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Assessment of Human Performance in a Simulated Rotorcraft Downwash Environment

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May 2007

Final Report for December 2004 to August 2005

Approved for public release; distribution is unlimited

Air Force Research Laboratory
Human Effectiveness Directorate
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14. ABSTRACT

Operational Requirements Document (ORD) CAF 315-97-B calls for the development of a Personnel Recovery Vehicle (PRV) to be used during Combat Search and Rescue missions undertaken by the Special Operations Command. Tests were conducted in the Aerospace Vehicle Survivability Facility of the 46th Operation's Group's Munitions Test Division (46 OGM), WPAFB to determine the horizontal and vertical airflow velocity limits in which personnel can perform necessary tasks. Horizontal test profiles included subjects walking into airflow wearing representative gear and carrying a Stokes litter with a patient. Vertical tests included descending a fast rope, climbing a ladder, and hoisting a litter into the airflow. Data analysis resulted in definition of horizontal airflow velocity limits. Vertical airflow limits were not defined due to poor experimental flow conditions. Horizontal flow is the limiting factor operationally as it is much stronger than vertical flow.

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PREFACE

The Special Operations Forces Systems Group (SOFSG/THE) requested that AFRL/HEPA provide air velocity limits for Pararescuemen (PJs) operating in the vicinity of a hovering Personnel Recovery Vehicle (PRV). Tests were conducted in the Aerospace Vehicle Survivability Facility of the 46th Operation's Group's Munitions Test Division (46 OGM), Area B, WPAFB. This testing was formally approved by the Wright Research Site Institutional Review Board (WRS IRB) under protocol F-WR-2004-0034-H and performed under work unit 71840216.

The work performed in this Technical Report was conducted between December 2004 to August 2005. John Plaga of AFRL/HEPA served as the principal investigator and project manager, with Nathan Wright and John Buhrman as associate investigators. Brian Grattan of General Dynamics AIS provided contractor support.

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INTRODUCTION

Operational Requirements Document (ORD) CAF 315-97-B calls for the development of a Personnel Recovery Vehicle (PRV) to be used during Combat Search and Rescue missions undertaken by the Special Operations Command. Section 4.1.1.7 of the ORD states that safe operations are not to be hindered due to PRV downwash. Safe operations are defined as the ability to perform “hover extraction operations (hoist), providing emergency lifesaving measures to isolated personnel, placement of a non-ambulatory personnel in a hoist recovery device, overland movement, self-protection, communication, and swimming.” Literature and data exist on rotorcraft downwash flow fields for a variety of aircraft. There is also limited literature on human limb aerodynamic coefficients and human performance in downwash flow fields. However, literature has not been found on human performance in flow fields during rescue operations or while carrying injured personnel on litters. Therefore, there was no data available in which to develop human performance criteria or modeling for this particular application. This necessitated a human test program in order to formulate human performance criteria for rescue operations such as litter transport in a downwash flow field.

BACKGROUND

Figure 1: HH-60 Pave Hawk

Helicopters have been used by the United States Armed Forces since the Korean conflict to quickly extract and transport injured soldiers from the battlefield to areas where medical care can be provided, and to locate and recover isolated aircrew members who had to abandon their aircraft. This capability was used extensively during the Vietnam conflict and resulted in a tremendous reduction in fatalities from combat injuries. Although many “MedEvac” flights were performed with the Army’s lightweight (10,000-lb) UH-1 Huey helicopters during ground extractions, the Air Force had been chartered with the Combat Search and Rescue (CSAR) mission. During the Vietnam conflict, more than two thirds of the 4,120 who found themselves isolated within enemy territory were recovered with three quarters of the rescues accomplished within two hours of notification, typically by the 22,000-lb CH-3 helicopters nicknamed "Jolly Green Giants" (Kennedy 2001). In the early 1980’s, the Army’s Huey helicopters were replaced by the UH-60 Black Hawk for troop transport. The USAF also replaced their CH-3 helicopters with a similar aircraft, the HH-60 Pave Hawk, for Search and Rescue missions. The 22,000-lb Pave Hawk (Figure 1) is a highly modified HH-60 that includes retractable in-flight refueling probe, internal auxiliary fuel tanks, and advanced avionics. Although the helicopter has been successfully used for the CSAR mission for the past 20+ years starting with Operation Just Cause in Panama, the aging airframe and small interior volume of the aircraft make it difficult for the crew to stow all of the required rescue equipment and provide adequate on-board care for an injured person.

In 1997 the Combat Air Forces (CAF) issued Mission Need Statement (MNS) 315-97, which was validated by the Joint Requirements Oversight Council Memorandum (JROCM) 005-99 (13 Jan 99) as ‘Mission Need Statement (MNS) for USAF Combat Search and Rescue (CSAR) Capability’. This MNS requested a medium-lift vertical take-off and landing aircraft to replace the existing Pave Hawk. Since all of the previous CSAR helicopters have had low-lift capabilities, this change to a medium-lift vehicle will result in a larger cabin volume to accommodate additional search and rescue equipment and to treat multiple patients. However, this higher lift capability comes with its drawbacks.

A vertical take-off and landing aircraft relies on moving a mass of air past the propeller blades in order to lift and keep the aircraft airborne. The heavier the aircraft, the higher the mass flow of air is required to lift the aircraft. This results in high speed downwash fields being generated below the aircraft. As the airflow approaches the ground, the ground redirects the vertical airflow into an accelerated horizontal flow. The flow then generally propagates in a radial pattern from the center of the aircraft, slowing as it moves outwards. The area directly under the rotors of the aircraft is relatively benign due to the radial motion of the airflow, but below the aircraft near the tips of the rotors, the air velocities become drastically violent. This violent airflow is know as the downwash field, and near heavy aircraft, can produce hurricane level winds, preventing a rescue crew from being able to perform their duties.

Various downwash velocities and qualitative ease-of-movement of personnel around for different aircraft have been reported. The downwash flow field velocity for the V-22 has been measured both on land and ship in different orientations with respect to the aircraft and for varying aircraft heights (Lake 1998, 1999). A peak velocity of ~104 mph for over land hover and ~92 mph for sea-board hover were measured at 0 deg relative to the aircraft at a distance of 38 feet from the aircraft center. Test subjects were used to qualitatively rate the difficulty of moving in the flow field. The “limit of forward movement while maintaining stability” varied with different body mass percentiles with 55 lbf for a 10%ile and 105 lbf for a 95%ile. A similar report for the CH-53E helicopter states a peak downwash velocity of 104 mph with a dominate pulse of ~1.5 Hz while at a gross weight of 70,000 lbs (Harris 1978). The downwash velocity is high, but it is consistent with a very high disc loading, the weight of aircraft divided by the area that the rotors rotate, of 36.5 lb/ft^2. As a comparison the UH-60, or Black Hawk helicopter, has a gross weight of 22,000 lbs with a disk loading of 11 lb/ft^2. Through talking with a Black Hawk mechanic, movement under the helicopter with the rotors turning is like walking “in a storm” and not easy.

A large volume of testing has been performed with humans subjected to air flow fields over the past 35 years. Wind tunnel tests were performed by Payne under contract by the Aerospace Medical Research Laboratory (AMRL) throughout the early 1970s to set airspeed limits for limb flailing during ejection and to check ejection seat stability. Between 1972 and 1974, Payne strapped a human volunteer into an ejection seat to measure the gross limb dislodgement forces in the hands, knees, and feet. Wind tunnel velocities ranged from 62-124 mph (q of 20-40 lb/ft^2) with yaw angles of 0 to 30 degrees (Hawker 1975). Payne suspended human volunteers from the wind tunnel ceiling and measured the aerodynamic drag of the human body in different body orientations including sitting, standing, and prone. In 1978 AMRL collaborated with the Air Force Flight Dynamics Laboratory (AFFDL) to conduct wind tunnel tests in the 40 by 80 foot wind tunnel at NASA Ames (Rogers 1978). A human subject was placed in the forebody of an F-16 to determine the tolerance to flying without a canopy both in a steady and unsteady flow.

The upstream air velocity ranged from 139-202 mph (q of 50-105 lb/ft^2). Additional wind tunnel tests were conducted at similar wind velocities in the 1980's at AMRL using human volunteer subjects to test ejection seat flow-stagnation concepts (Specker 1990).

In a study by Swearington and McFadden (Schane 1967), test subjects were subjected to windblast while in different orientations. The study was performed to see a human's reaction to rapid depressurization of an aircraft. Two "limits" were set: imbalance and complete disorientation beyond recovery. It was found that a wind velocity of 57.5 mph caused a temporary imbalance of the test subject that was recoverable. A wind velocity of 86 mph caused an unrecoverable imbalance. Though the testing was not specifically designed to set limits of human performance in windblast, the test data correlates well with anecdotal field data.

The results of this program will be used to establish human performance versus airflow velocity criteria for both horizontal and vertical airflows, filling a relatively large gap in biodynamics testing. The data will be used in the selection of a Personal Recovery Vehicle (PRV) or a Combat Search and Rescue (CSAR) vehicle to be used by Air Force Special Operations Command. Without the experimental data obtained from this human test program, the safety and performance of rescue personnel using this vehicle could be compromised.

METHODS

Test Facility. All tests for the program were conducted at the 46th OGM Aerospace Vehicle Survivability Facility (AVSF) Range 3 facility located at Wright-Patterson AFB. This facility provides for the Research, Development, Testing and Evaluation (RDT&E) and transition of DoD technologies related to aircraft survivability aspects of fuel fire and explosion, projectile threats, hydrodynamic ram, inlet fuel injection, armor, structural damage and repair, and airflow effects on damage. The facility employs "bypass air" from jet engines that are capable of producing wind speeds of over 460 mph with air temperatures less than 90 degrees F at the test section. The AVSF uses a modern data acquisition system to precisely conduct test programs and record, process, analyze, refine for presentation, and archive data. The test facility also provided several fixed and panning cameras to digitally record the performance of each subject during each test.

Figure 2: Test Section

For the horizontal velocity tests, bypass air from the lower 2 engines (Lower Range 3) were used to provide the airflow (Figure 2). A raised wooden floor covered with artificial turf was constructed in the test area and marked with paint at 5 foot increments to show distances away from the exit of the air nozzle. Calibration runs were conducted by measuring temperatures and both average and time-dependent (10 second window) velocities (one dimensional) at 2.5 foot increments at 1,3, and 5 feet above the ground along the center line of the nozzle of the range at exit velocities of 60, 80, 100, and 120 KEAS (12.2, 21.7, 34.0, and 49.1 PSF). Structural padding to minimize any potential injuries to the subjects were installed within the windblast area and were inspected prior to each test day to ensure they remained secured.

Figure 3: Upper duct

For the vertical tests, the engine bypass air from the top 5 engines in the upper test range were ducted down through a hole in the metal grating floor of the upper test ranges into the lower test section (Figure 3). The flow was very unsteady and not purely vertical, so the data were only qualitatively analyzed.

Preliminary Testing: Prior to the start of human testing, preliminary tests were conducted the week of 17 January 2005 at the highest nozzle output wind velocity of the test program with a large, dressed manikin. Tests were performed with the manikin sitting on a chair in the airflow and laying in the airflow both with and without a helmet to measure sound pressure levels (SPLs), drag force, neck loads, air temperature, and dynamic pressure within the test section. In addition SPLs were measured where the test conductors and medical monitors were to stand during actual testing to ensure that the required hearing protection required by the range would be sufficient for long periods of time. The test facility sound pressure levels were also monitored by the Wright-Patterson Bioenvironmental Office to ensure proper hearing protection.

Test Subjects and Equipment. The test panel was comprised of both male and female human volunteers. Initial testing was conducted with volunteers recruited from the AFRL/HEPA Impact Acceleration Panel (IAP) and fitted with protective gear similar to that worn by the PJ's.

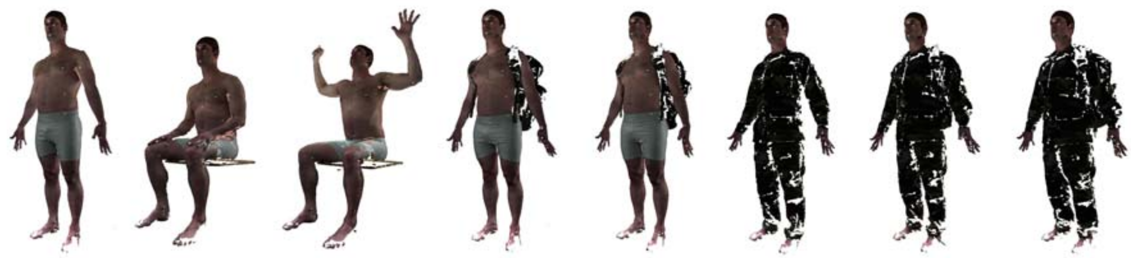


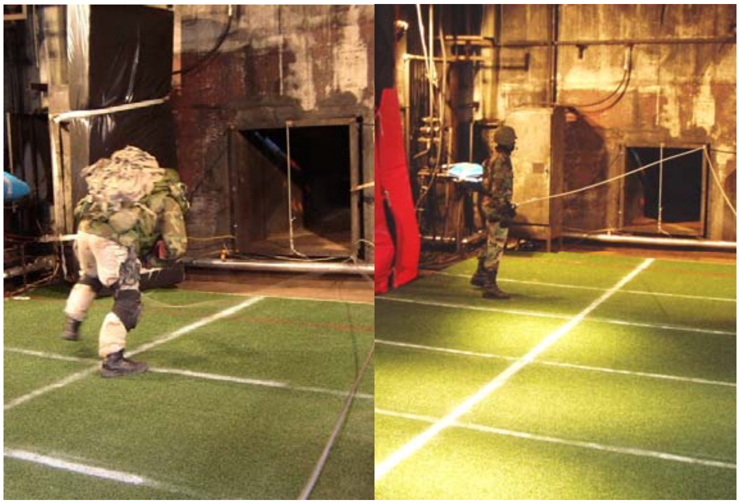
Figure 4: Sample of 3D Whole Body Scan

The baseline subjects wore clothing similar to that worn by PJ's during their rescue missions, which included Battle Dress Uniform (BDU's), Modular/Integrated Communications Helmet (MICH), eye safety goggles, standard military boots, gloves, and hearing protection. Height, weight, and other pertinent anthropometry measurements were taken of the subjects and maintained in the AFRL/HEPA Biodynamics Data Bank. Additional subjects included two Survival Evasion Resistance Escape (SERE) instructors and one non-active PJ. These tests subjects were used to validate the testing methodology and to provide baseline performance data for the horizontal airflow testing. To accurately assess the performance of rescuers, a group of volunteer Special Operations PJ's wearing their typical combat search & rescue (CSAR) equipment were also used in a later phase of testing. The PJs were 3D whole body scanned with and without their gear (Figure 4). The majority of these later tests were performed by both active Air Force members from Moody AFB and Air Guard pararescumen volunteers (Figure 5). A total of 9 active PJs participated. The subjects were loosely tethered to rigid structures and tended by test personnel outside the main windblast area to minimize uncontrollable motion should a fall occur.

Figure 5: Operational PJs with Standard Gear

Table 1: Test Subjects					
Subject ID	Height (in)	Weight-Minimum, no Body Armor	Weight-Minimum, w/Body Armor (lbs)	Weight-35lb pack	Weight-60lb pack
C-32	65	190	205	240	265
D-18 (F)	70	170	185	220	245
GT	69.5	180	195	230	255
M-47	71.5	205	220	255	280
P-14	70	245	260	295	320
PJ-1	69	185	200	235	260
PJ-10	74	217	232	267	292
PJ-2	70	216	231	266	291
PJ-3	72	218	233	268	293
PJ-4	71	216	231	266	291
PJ-5	70	227	242	277	302
PJ-6	71	285	300	335	360
PJ-7	69	178	193	228	253
PJ-8	69	194	209	244	269
PJ-9	71	219	234	269	294
R-27	71.5	180	195	230	255
S-39 (F)	66	130	145	180	205
SI-1	75	248	263	298	323

Procedures. Each subject was screened prior to testing with baseline vital signs to include: blood pressure, pulse rate, and respiratory rate. Prior to their first exposure, each subject received a briefing on the test objectives, procedures, medical risk, and each subject signed an informed consent form. All subjects were briefed on emergency procedures and test protocol. The subjects were instructed to remove all extraneous personal objects such as rings and bracelets. Prior to testing all non-PJs received training in proper body positioning and bracing techniques for walking during the windblast exposures, as well as proper procedures for lifting, carrying and hoisting the Stokes litter. These techniques and procedures were based on the recommendation of experienced pararescue personnel. All subjects were first tested at low windblast exposure levels to ensure implementation of these procedures and to allow the test subjects to become familiar with the flow field. The subjects were fitted with their test gear. The subjects were tethered to rigid structures and tended by test personnel outside the main windblast area. While the engines were at idle, the tethered subjects moved to the center of the far end of the raised platform and waited for the airflow velocity to be



A **B**

Figure 6: Subjects walking into the flow (a) and stepping outside the flow (b)

increased to the test level, at which point a hand signal was given to the subjects to proceed into the flow (Figure 6a). The subjects proceeded into the increasing airflow until they could no long advance forward, then they moved to the side which was outside the airflow (Figure 6b), and walked back to the far end of the facility as the engines were returned to idle speed. The experimental test matrix for the horizontal airflow tests is summarized in Table 2, followed by brief descriptions of each cell configuration. Table 3 summarizes the vertical airflow tests.

Table 2: Horizontal Cell Description

Cell	Description	Backpack	Body Armor	Litter	Manikin
A-1a	No backpack, no body armor	No	No	No	No
A-1b	No backpack, body armor	No	Yes	No	No
A-2a	30lb backpack, no body armor	30	No	No	No
A-3a	55lb backpack, no body armor	55	No	No	No
A-3b	55lb backpack, body armor	55	Yes	No	No
B-1a	Litter, L-Case 1, no body armor	No	No	Yes	L-Case 1
B-1b	Litter, L-Case 1, body armor	55	Yes	Yes	L-Case 1
B-2a	Litter, L-Case 1+55lb, no body armor	No	No	Yes	L-Case 1+55lb
B-3a	Litter, Medium, no body armor	No	No	Yes	50%
B-3b	Litter, Medium, body armor	55	Yes	Yes	50%
C-a	Ambulatory, no body armor	No	No	No	No
C-b	Ambulatory, body armor	No	Yes	No	No
D-1	Forward/Back, no litter	No	Yes	No	No
D-2	Forward/Back, Litter	No	Yes	Yes	No
E	Crouching	No	Yes	No	No
F-1	Kneeling, w/o backpack	No	Yes	No	No
F-2	Kneeling, with backpack	30	Yes	No	No
G	Zig Zag with backpack	30	Yes	No	No
H	Horse collar	30	Yes	No	No
I	Life pack	30	Yes	No	No
T-1a	Training, no backpack, no body armor	No	No	No	No
T-1b	Training, no backpack, body armor	No	Yes	No	No
T-2a	Training, 30lb backpack, no body armor	30	No	No	No
T-2b	Training, 30lb backpack, body armor	30	Yes	No	No

Table 3: Vertical Cell Description

Cell	Description	Backpack	Body Armor	Litter	Manikin
J1	Hoist litter, Case 1 manikin,	No	Yes	Yes	Case 1
J2	Hoist litter, Case 1 manikin, 50%ile barrelman	No	Yes	Yes	Case 1, 50%ile
K1	Hoist litter, Case 6 manikin	No	Yes	Yes	Case 6
K2	Hoist litter, Case 6 manikin, 50%ile barrelman	No	Yes	Yes	Case 6, 50%ile
L1	Hoist empty litter	No	Yes	No	No
M1	Rope ladder	No	No	No	No
M2	Rope ladder, backpack	yes	No	No	No
N1	Fast rope	No	No	No	No
N2	Fast rope, backpack	yes	No	No	No

Figure 7: Cell A-2a

Figure 8: Cell B-1a

Figure 9: Cell C-a

Figure 10: Cell D-2

Cell A-x: Subjects were first asked to walk into the flow without any additional gear. Next, subjects were asked to wear a pack that added 35 pounds of additional weight and then 60 pounds respectively of additional weight (Figure 7). The purpose of this cell was a baseline for the other tests. The addition of a back pack and weight changed the aerodynamics of the subject as well as increased the surface friction.

Cell B-x: Subjects wore flights suits and BDUs along with helmets, gloves, and goggles. Two test subjects of varying size and weights were instructed to pick up a Stokes litter and carry it as far as they felt they could go in the flow. Only the front subject was tethered. Hand signals and gestures were arranged to allow the subject at the rear of the litter know what the subject in the front was going to do. Three different sizes and weights of patient manikins were used: a 103 lb Case 1 manikin, a Case 1 manikin with an additional 55 lbs added, and a large 240lb Case 6 manikin (Figure 8). Through this cell it was seen that subjects could walk further than when alone as the subject at the rear was shielded by the airflow and generally pushed the front subject further.

Cell C-x: Cell C used an additional test subject as a "patient" limping being helped from the side by a medic to simulate an ambulatory case (Figure 9). Both subjects were tethered by a common line.

Cell D-x: PJ subjects wore body armor and survival vests along with helmets, goggles, and gloves. Subjects were asked to walk into the flow with the litter as they would operationally and then turn around and walk to the back of the test section. The litter was held vertically and to the side (Figure 10). It was noticed that the litter caught much more air than it did when held between the subjects and the subject at the rear could not push the front subject into the flow as easily, causing more instability at a lower velocity than Cells B-x.

Figure 11: Cell F-2

Figure 12: Cell I

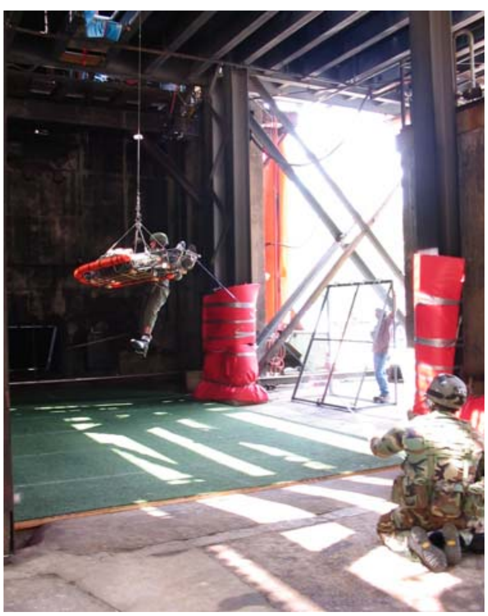


Figure 13: Cell K2

Cell E: The subjects stopped at the 5 foot increments on the ground and the airflow was ramped up. The flow was then cut, the subject approached another 5 feet, and the flow again ramped. Subjects wore body armor and backpacks. This was to simulate a helicopter approaching and to observe the subject's stability in the flow.

Cell F-x: subjects were instructed to kneel at 5 foot increments at one nozzle airspeed and then continue on to the next 5 foot increment (Figure 11). This cell was included to look at stability and mobility within the flow.

Cell G: subjects wore a 30 lb backpack and crossed perpendicular to the flow at the 5 foot increments. With the flow being relatively narrow, the entering and exiting of the cross flow attributed to the stability of the subjects in unsteady flow. Operationally, a helicopter coming to a pick up point causes a strong airflow "wave" to hit the PJs.

Cell H: Subjects were instructed to place a horse collar around another subject while in the airflow.

Cell I: The subject wore body armor, a 30 lb backpack, and carried an additional 30 lbs in handbags to simulate medical supplies (Figure 12). The addition of the handbags substantially changed the aerodynamics of the subject and was more difficult.

Cells Jx, Kx, and L1: A litter with a manikin and a barrelman was hoisted into the vertical flow. This cell was included to see how well the subject could guide the litter and barrelman into the flow (Figure 13).

Cell Mx: A standard rope ladder used in Combat Search and Rescue (CSAR) aircraft was mounted near the exit of the vertical airflow nozzle, approximately 25' above the ground. Trained and qualified PJ's wore a climbing harness and were connected to a safety rope that was run through a carabineer (secure ring) at the top of the test fixture and then down to a trained belayer at the bottom of the test range. The subject climbed up the rope ladder into the airflow at increasing air velocities (no greater than 130 mph) to within 5' of the nozzle exit in order to


Figure 14: Cell M2

determine the maximum air velocity that this activity can be accomplished (Figure 14). Another subject secured the bottom of the ladder to prevent whipping and provide stability.

Cell Nx: The subject descended a fast rope that was attached through the center of the duct (Figure 15). Another subject held the rope from flopping around in the airflow. The subject was tethered and belayed by another subject. Tests with and without backpacks were run.


Figure 15: Cell N1

On 7 February 2005, initial human orientation tests were conducted. Testing logistics were checked and modified as necessary. Different scenarios were rehearsed and proper testing levels recorded. Humans were put into the flow and asked to perform tasks listed in the test matrix. This day of testing was also practice for the test facility to use lighting, cameras, and general procedure. Human testing continued 14-16 February with a mix of test subjects from the HEPA Impact Test Panel (ITP), two Survival, Evasion, Resistance and Escape (SERE) instructors, a non-active PJ, and military members from ASC involved with the program. A total of seven subjects, two of whom are female, participated in the testing. Of these seven, four completed all testing. The subjects were examined by medical personnel after each test to ensure they could continue testing.

During 7-9 March, additional horizontal flow tests were conducted with Air National Guard PJs. The PJs wore their operational gear which included: helmets, body armor, and survival vests. The vertical airflow tests and some additional horizontal airflow tests were conducted in April using Active Duty PJs.

Vertical tests were conducted with PJ subjects as described in Table 3. This included the subjects descending a fast rope, climbing a rope latter up into the flow, and using a hoist to raise a litter with varying manikin occupants up into the flow.

A total of 391 horizontal flow tests were performed with both male and female subjects. Seventy-five vertical flow tests were conducted with PJs subjects descending a fast rope, guiding a litter ascending into the airflow with different occupant weights, and climbing a rope ladder into the flow with different gear configurations.

Upon completion of the testing, the videos were analyzed to determine the farthest forward motion of each subject for each test. A subjective determination of a stumbling point or first difficulty point was also determined if possible. This information was correlated against the flow mapping of the test facility and the engine parameters to estimate the air velocity at these

points. These data were tabulated and analyzed against various variables such as subject weight and subject type to determine any trends or correlations.

RESULTS

Eighteen subjects participated in this experiment (9 PJs, 7 non-PJ males, 2 non-PJ female) generating 286 final velocities across all horizontal cells. The height and weight of the PJs ranged from 69-74 inches and 164-261 lbs respectively. The height and weight of the non-pararescumen males ranged from 65-75 inches and 175-243 lbs respectively. The females heights were 66 and 70 inches and weights were 125 and 165 lbs respectively.

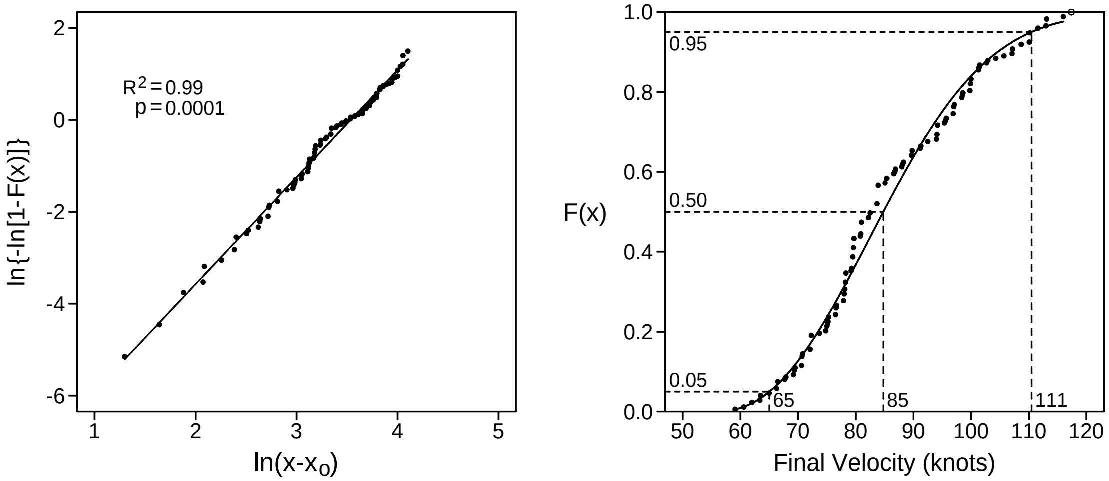


Figure 16: Sample Cumulative Distribution – All Subjects

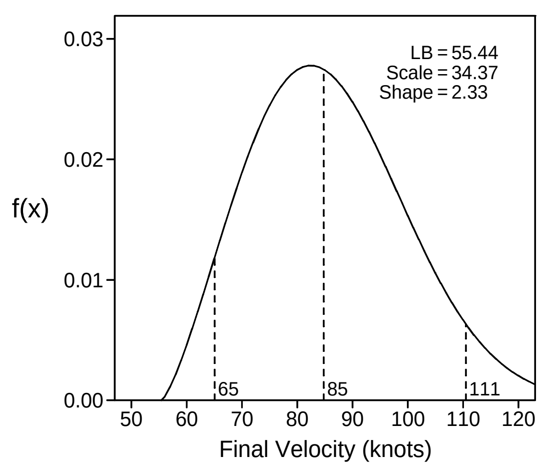


Figure 17: Cumulative Distribution – All Subjects

Figures 16 and 17 show the fit of final velocity sample cumulative proportions using the Weibull cumulative distribution. All PJ final velocities were used (n = 173). Which cells and subjects the values came from were not considered. Referenced values are 5th, 50th, and 95th percentiles.

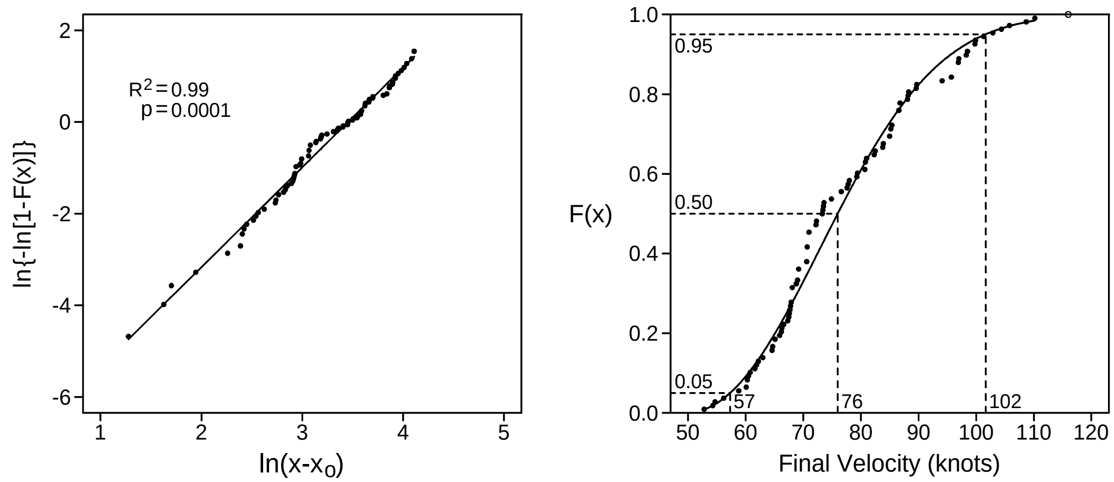


Figure 18: Sample Cumulative Distribution - PJs

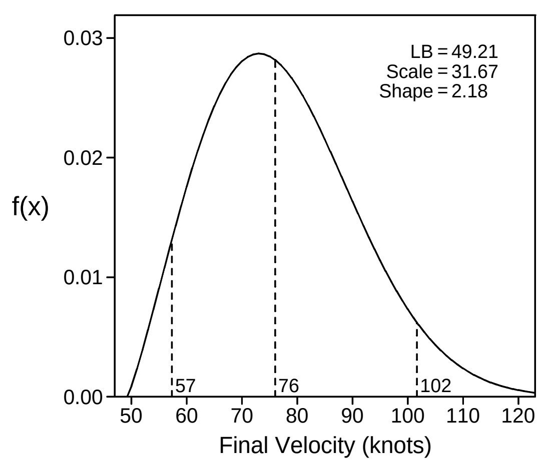


Figure 19: Cumulative Distribution - PJs

Figures 18 and 19 show fit of final velocity sample cumulative proportions using the Weibull cumulative distribution. All non-PJ males final velocities were used (n = 109) except for a final velocity of 47 (cell C-a) which hurt the fit too much to be included. Which cells and subjects the values came from were not considered. Referenced values are 5th, 50th, and 95th percentiles.

DISCUSSION

The purpose of the analyses was to: (1) determine if there is a relationship between the maximum velocities subjects can achieve and the subjects' weight, (2) generate a distribution of maximum velocities subjects can achieve for each cell, and determine which cell resulted in the limiting performance factor, (3) generate an overall distribution of maximum velocities subjects can achieve for all cells combined, (4) determine differences in maximum velocities subjects can achieve, if any, between PJs and non-PJ males.

Test Facility Flow Field: Prior to the start of human testing for the horizontal airflow tests, the test facility conducted flow mappings by measuring total pressures at the exit nozzle and at five foot increments away from the nozzle along the nozzle centerline at 1, 3, and 5 feet above the ground. These data were collected for four exit velocities and were used to estimate the velocity where the subjects were no longer able to proceed into the airflow based upon the exit velocity and the maximum achieved distance from the exit nozzle. Upon analyzing the data from the first two human test series, it was determined that the five foot increments downrange from the exit nozzle was not sufficient to accurately determine the subjects' maximum obtained velocity. Therefore, the test facility conducted another flow survey in which the pressure measurements were taken in 2.5 foot increments from the nozzle.

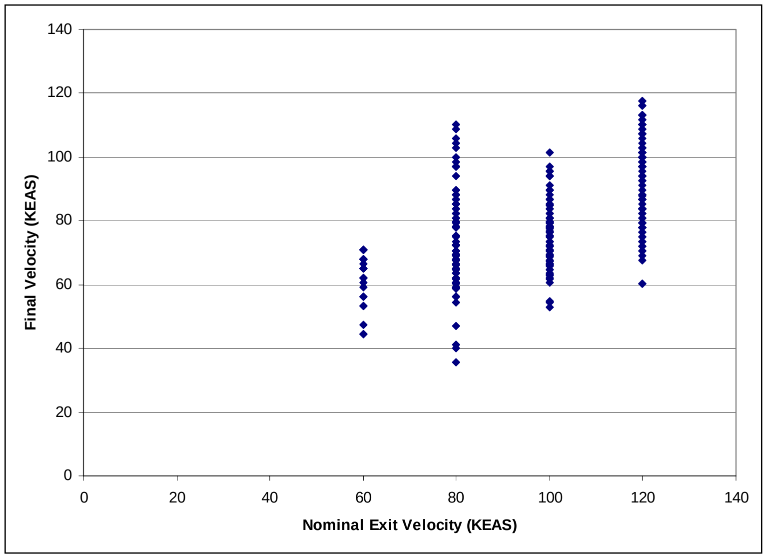


Figure 20: Final Velocity vs Nominal Exit Velocity

When the results from the second flow mapping were compared to the first, there were large discrepancies. This lead to a third flow mapping attempt using pitot-static pressure tubes rather than total pressure tubes as was used earlier. When data from this third flow mapping were used to estimate the subjects' maximum obtainable velocities, there were significant differences for each of the exit velocities. This indicated that the correlations between the exit velocity and the velocities downrange that were determined during the flow mapping were inconsistent, and that some parameter or parameters other than exit velocity alone had an effect on the downrange velocities. When the flow mapping data were correlated against the test runs, discrepancies existed which led to further examination that determined the test reference pressures (used to determine downrange velocities) did not uniquely identify downrange velocities. This could be seen when the final velocity achieved by the subjects were plotted against the nominal exit velocity (Figure 20) as the velocity achieved also increased as the exit velocity increased, which is counter-intuitive if the flow gradients are close to the same for different nominal exit velocities.

In order to better understand the test facility flow field, detailed analysis of the flow mapping data against Computational Fluid Dynamics (CFD) was used to model the flow from the two aircraft engines, through the air duct, and out into the test section (Figures 21 and 22). The CFD analysis indicated that the engine RPM had a major effect on downrange velocities. The CFD simulations conducted by ASC/ENFT resulted in a set of air velocity data as a function of engine RPM, ambient temperature, and ambient pressure. Since the CFD simulations only bounded the parameters of the actual testing, a linear regression was formed from the CFD data. The velocity at different positions in the flow was found using only the Total %N1 (the sum of the rotor speeds from each engine as a percentage of maximum rated speed) and position in the flow as independent variables.

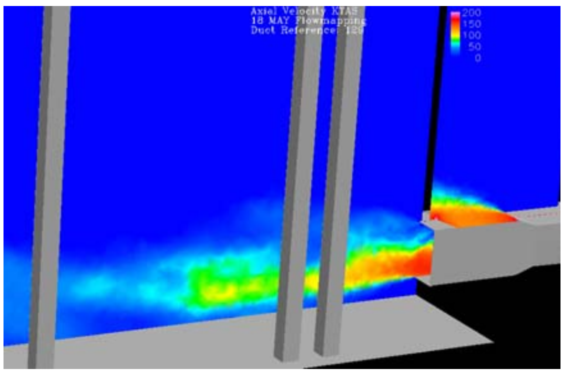


Figure 21: CFD Flow Field of Test Section

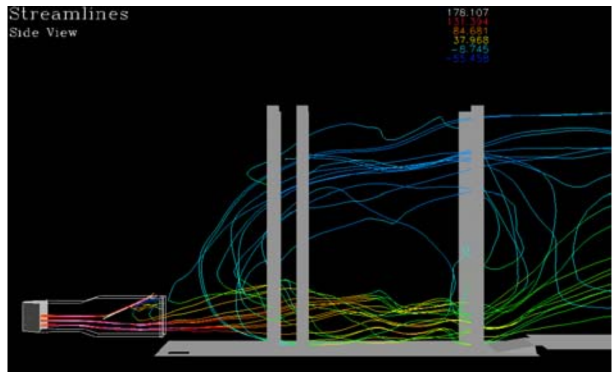
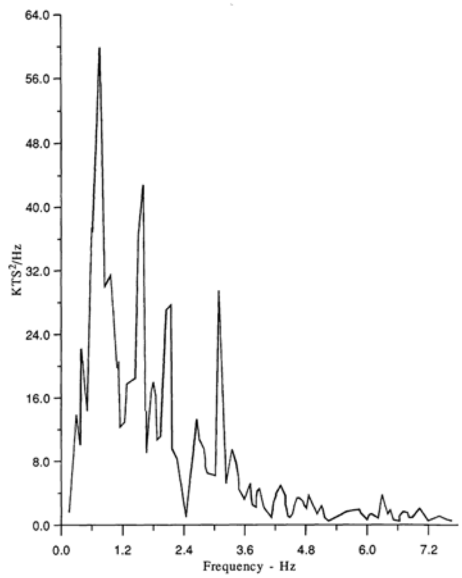


Figure 22: CFD Streamlines of Test Section

$$\text{Velocity (in KEAS)} = -1.29 + 1.45(\%\text{N1}) - 2.94 * (\text{Position in feet})$$

This relationship has an R-squared value of 0.97. Ambient temperature and pressure were found not to be important variables in fitting the CFD data.

<u>Airflow Differences Between Test Facility and Rotorcraft:</u> There were some considerable differences in the flow within the test facility and flow experienced from rotorcraft downwash. Test Reports of measurements of downwash from various rotorcraft indicate that there are relatively large oscillations in the airflow. The variations can be up to 45 knots peak-to-peak for a helicopter such as the CH-53E with frequencies of these oscillations typically in the 1-4 Hertz range (Figure 23) (Ferguson 1994). The airflow in the test facility was predominately steady state with only high frequency oscillations that generally did not have a noticeable effect on the subjects. The PJ test subjects felt that the steady state nature of the test facility made it much easier to maintain balance and proceed forward into the increasing air velocity than in the oscillatory downwash conditions encountered during their missions with rotorcraft.



Source: Reference 24.

FIGURE 9 POWER SPECTRAL DENSITY OF THE CH-53E TIME SERIES PRESENTED IN FIGURE 8

Figure 23: CH-53E Airflow Velocity Frequency Oscillations

The flow mapping and CFD analysis of the three-dimensional flow indicate large variations in velocities from the subjects' feet to head, with a peak velocity occurring at approximately 2 feet above the ground. Reports containing horizontal airflow data collected during tests of various rotorcraft and CFD analysis of PRV candidates indicate that airflow is generally the greatest just above the surface of the ground and decays as it moves farther above the ground. These differences in velocity profiles result in different locations of the center of pressure and the total equivalent velocities on the subjects in the test scenario versus them being in the airflow of actual rotorcraft.

PJ-1 was included in the active airmen test pool as he was no longer an active pararescumen in the field. In looking at the data, PJ-1 final velocities were consistently closer to that of the non-Pararescuemen airmen and he was removed from cells D-1, D-2, E, G, and I. Analyzing his data with regular Airmen was felt to give a better picture of what velocities the active pararescumen can truly withstand and still perform their tasks.

The two females were not used in any analysis as the sample size was too small and there are currently no female PJs. For all analyses, replications from the same subject were considered independent as if they came from a different subject.

There was only one cell (A-1a, no backpack or body armor) where PJs and non-PJs both performed. To compare the performance of PJs vs. non-PJs, an analysis of covariance was performed for cell A-1a. Final velocity was the dependent variable. The factor was group (PJ, non-PJ) with covariates body weight and total %N1. An unequal slopes model did not find any significant interactions ($p > 0.4476$), therefore, an equal slopes model was used. The F-test found a significant difference between the groups {$F(1,35) = 23.76$, $p = 0.0001$}. Least squares means were determined for each group. The means are estimated means for each group at the average value of the covariates and were: 78.8 knots for PJs, 67.1 knots for non-PJs. The slope for body weight was significantly different from 0 ($p = 0.0117$) with an increase of 1 lb in body weight corresponding with a 0.13 increase in final velocity. The slope for total %N1 was not significantly different from 0 ($p = 0.7986$).

Analyses determined that the height of the subject had no meaningful influence on final velocity, however, the subject's weight did in at least some cells.

Table 4: Cell Correlations to Engine Strength and Body Weight

			Total %N1		Body Weight (lb)	
Cell	**Cell Description**	**Subjects**	**Slope**	**p**	**Slope**	**p**
A-1b	No backpack, body armor	PJ	1.22	0.0001	0.16	0.0008
A-2a	30lb backpack, no body armor	non-PJ	0.02	0.8616	0.13	0.0809
A-2b	30lb backpack, body armor	PJ	0.89	0.0002	0.17	0.0100
A-3a	55lb backpack, no body armor	non-PJ	0.34	0.0139	0.21	0.0028
A-3b	55lb backpack, body armor	PJ	0.75	0.0110	-0.02	0.7258
B-1a	Litter, L-Case 1, no body armor	non-PJ	2.26	0.0183	0.31	0.0016
B-1b	Litter, L-Case 1, body armor	PJ	1.64	0.0023	0.14	0.0197
B-2a	Litter, L-Case 1+55lb, no body armor	non-PJ	0.07	0.9355	0.19	0.0829
B-3b	Litter, Medium, body armor	PJ	1.30	0.0059	0.05	0.3229
C-a	Ambulatory, no body armor	non-PJ	0.71	0.4473	0.33	0.0144
C-b	Ambulatory, body armor	PJ	1.42	0.0017	0.14	0.0645
D-1	Forward/Back, no litter	PJ	1.17	0.0041	0.12	0.1832
D-2	Forward/Back, litter	PJ	1.53	0.2294	0.08	0.7011
E	Crouching	PJ	0.76	0.1945	0.08	0.6244
G	Zig Zag with backpack	PJ	1.67	0.0047	-0.08	0.3193
I	Life pack	PJ	0.43	0.0361	0.21	0.0022

Table 4 shows the results from linear regression with final velocity as the dependent variable. Independent variables were Total %N1 and body weight. For cells D-1, D-2, E, G, and I, the one non-PJ was removed from analysis.

Table 5: Cell Data Distribution

			Percentiles (knots)				
Cell	**Cell Description**	**Subjects**	**min**	**25**	**50**	**75**	**max**
A-1a	No backpack, no body armor	non-PJ	53	61	68	71	85
		PJ	66	78	80	81	94
A-1b	No backpack, body armor	PJ	59	68	71	79	87
A-2a	30lb backpack, no body armor	non-PJ	62	65	68	73	82
A-2b	30lb backpack, body armor	PJ	64	76	82	89	100
A-3a	55lb backpack, no body armor	non-PJ	61	71	78	87	101
A-3b	55lb backpack, body armor	PJ	69	72	78	81	99
B-1a	Litter, L-Case 1, no body armor	non-PJ	82	87	97	100	109
B-1b	Litter, L-Case 1, body armor	PJ	97	100	101	112	116
B-2a	Litter, L-Case 1+55lb, no body armor	non-PJ	85	93	97	101	110
B-3b	Litter, Medium, body armor	PJ	97	101	107	110	117
C-a	Ambulatory, no body armor	non-PJ	47	65	77	87	104
C-b	Ambulatory, body armor	PJ	68	79	88	94	101
D-1	Forward/Back, no litter	PJ	71	80	82	97	100
D-2	Forward/Back, litter	PJ	62	65	76	84	90
E	Crouching	PJ	78	84	92	103	112
G	Zig Zag with backpack	PJ	90	94	104	113	117
I	Life pack	PJ	64	74	77	84	98

Table 5 gives the minimum, maximum, and percentiles in knots for each test cell based on the available test data. Overall estimated distributions for non-PJ males and PJs are not comparable for multiple reasons but most importantly since they are not balanced in how many values come from particular cells. The only valid comparison of non-PJ males vs. PJs is from Cell A-1a. In addition, since there was no control about which subjects performed in which cells, and how

many times, both of the estimated distributions should be considered rough estimates and one should be cautious in using these estimated distributions to make conclusions.

Qualitative Horizontal Airflow Tests: A few test cells could not be analyzed with the other cells as they were significantly different enough and did not give a true measure of final velocity. These cells were still useful in looking at general human reaction to being in a high-speed airflow and can be analyzed qualitatively and general observations can be made.
Kneeling (Cells F-1, F-2): Subjects were instructed to stop at each 5 foot mark away from the nozzle exit. While at each mark, the airflow velocity was increased to 120 knots. These cells were included to look at relative stability of the subjects in a ramping flow, something a PJ would encounter for a helicopter coming in to a landing area for pickup of aircrew and patients. The initial "whoosh" from a helicopter would be considerably quicker and stronger than that of what was tested but it still gave a good idea of general stability and relative strain on the subjects. Subjects were able to stay their position, though it would have been extremely difficult to change positions if required.

Horse collar (Cell H): Subjects were instructed to place a horse collar around another subject while in the airflow. It was shown that it was difficult to don a horse collar on a subject in an intense airflow (80 knots at the 10 ft line). If the horse collar had not been restrained, it could have very easily been lost and blown downstream, making it inaccessible to the PJ in real conditions.

Vertical Airflow Testing: Given that the flow for the vertical portion of the downwash testing was very turbulent and not purely vertical, there was no reliable data that could be quantitatively analyzed. Still, qualitative observations can be made.

Hoist litter (Cells J, K, and L): A PJ was instructed to guide a litter into the vertical flow. The litter was shown to be more stable as the occupant became heavier. With no manikin or the Case 1 small manikin, the litter was more prone to swing violently, making it more difficult for the PJ to control.

Rope ladder (Cell F): PJs were asked to climb a rope ladder up into the vertical flow. A PJ held the bottom of the rope ladder to keep it from swinging violently. Still, subjects on the ladder found it very difficult to climb the ladder.

Fast rope (Cell N): Subjects did not have difficulty descending the fast rope while in the flow.

SUMMARY

Testing to simulate helicopter downwash was performed to set velocity limits. Based upon the above test data, AFRL/HEPA recommends instituting an air velocity limit of 65 knots to enable PJs to approach a hovering rotorcraft. This velocity limit results in all of the PJs who participated in the study being able to approach a hovering rotorcraft while wearing their standard gear, and 95% of the PJs in the study being able to approach the hovering rotorcraft while carrying additional gear in their hands.

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APPENDIX A: SUBJECTIVE RESPONSE QUESTIONAIRE

Downwash Program

Study	Test No.	Subj ID	Test Cell	Position	Test Velocity	Test Date
Downwash						

IMPRESSION OF WINDBLAST

Mild 1 2 3 4 5 Severe

VARIATIONS IN WIND SPEED

None 1 2 3 4 5 Very noticeable

PHYSICAL DISCOMFORT/PAIN

Comfortable 1 2 3 4 5 Uncomfortable

MOVING IN WIND

Easy 1 2 3 4 5 Difficult

MAINTAINING BALANCE

Easy 1 2 3 4 5 Difficult

HOISTING STOKES LITTER

Easy 1 2 3 4 5 Difficult N/A

HELMET/HEARING PROTECTION

Comfortable 1 2 3 4 5 Uncomfortable

BODY EQUIPMENT

Comfortable 1 2 3 4 5 Uncomfortable

LOCATION AND TYPE (DULL, SHARP, ETC.) OF ANY DISCOMFORT OR PAIN EXPERIENCED:

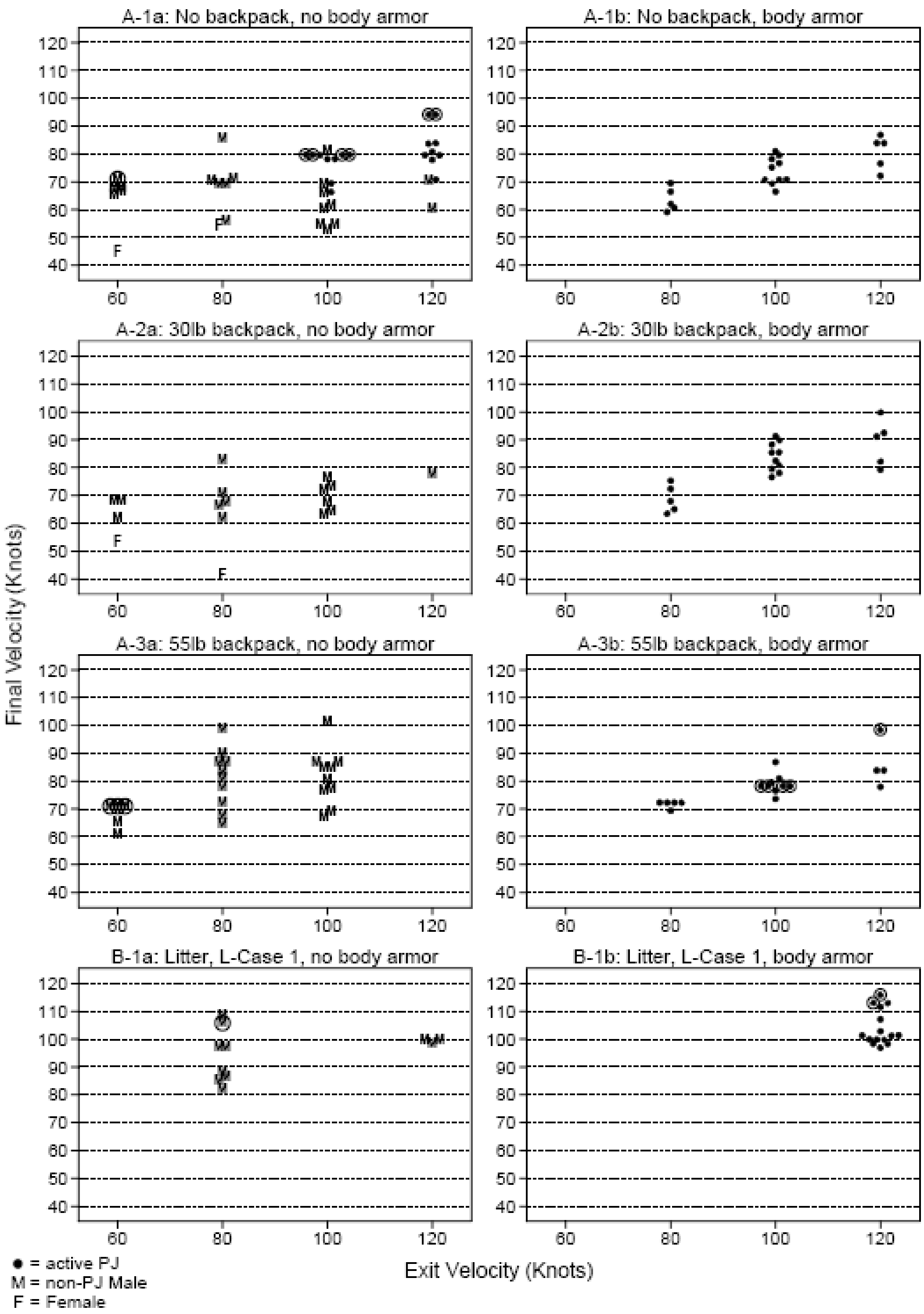
SPECIFIC DIFFICULTIES ENCOUNTED:

OTHER COMMENTS:

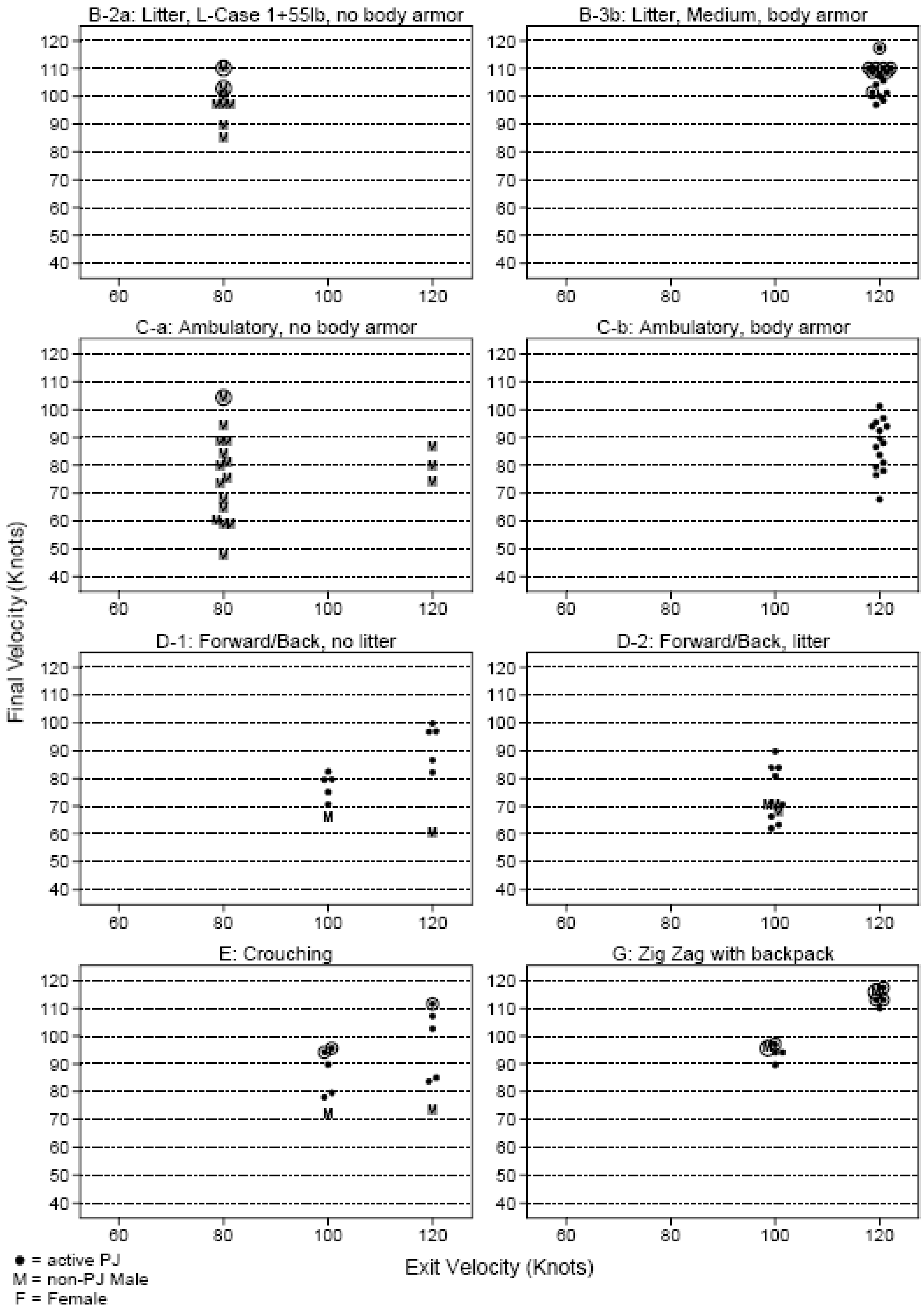
LIST AIRCRAFT THAT YOU HAVE EXPERIENCE OPERATING IN THE DOWNWASH FIELD (IF APPLICABLE):

HOW DOES THIS TEST COMPARE WITH EXPOSURE TO ACTUAL ROTORCRAFT DOWNWASH (SPEED, OSCILLATIONS, ETC)?

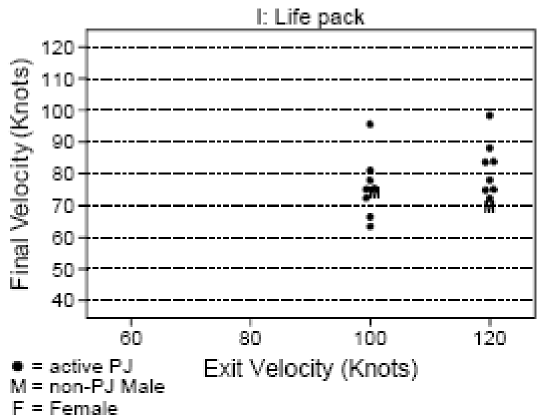
APPENDIX B: DATA PLOTS



Final velocity for each cell, subject, and replication. PJ-1 was considered a non-PJ male. Final velocities with a final position = 5 ft are circled.



Final velocity for each cell, subject, and replication. PJ-1 was considered a non-PJ male. Final velocities with a final position = 5 ft are circled.



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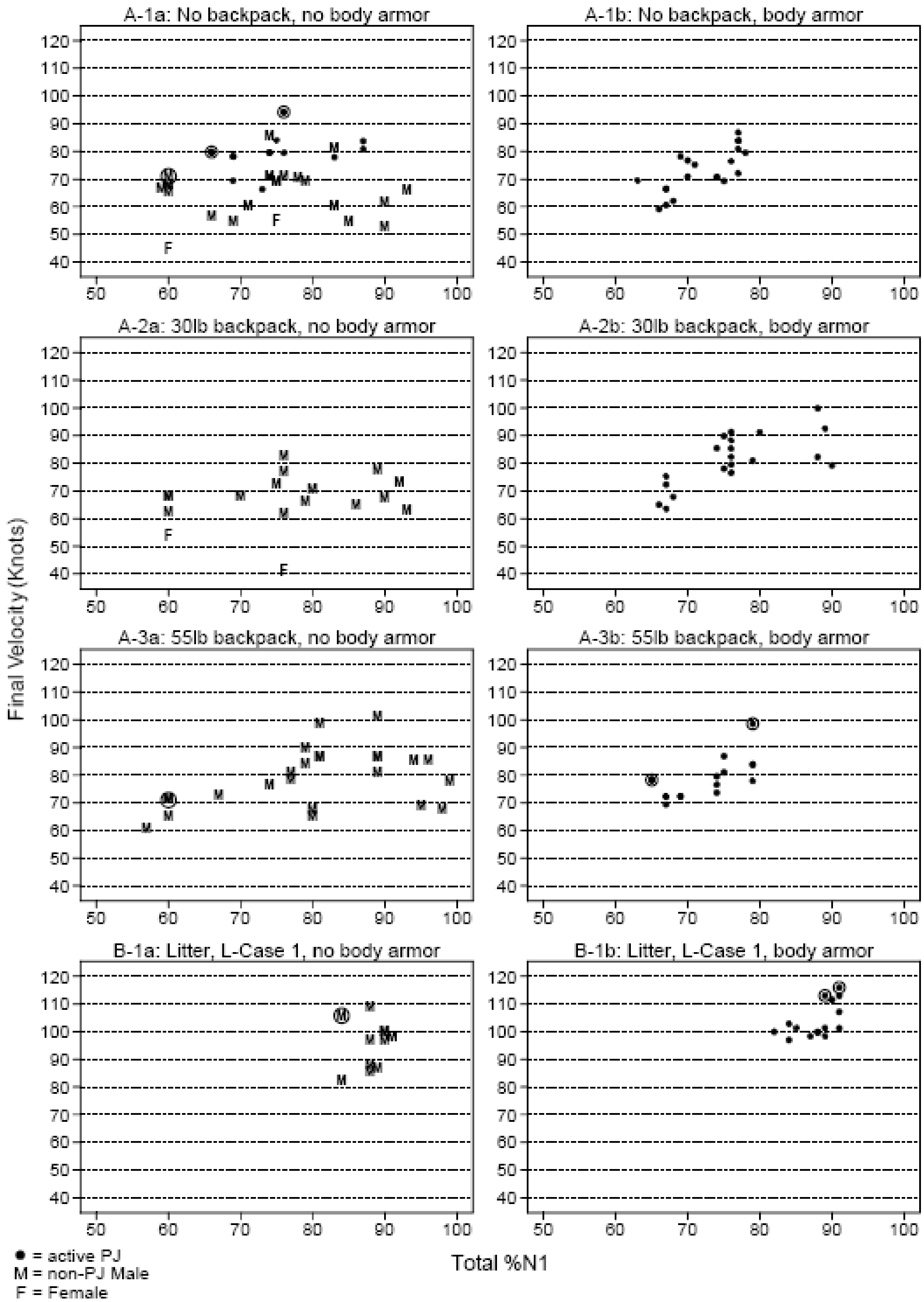

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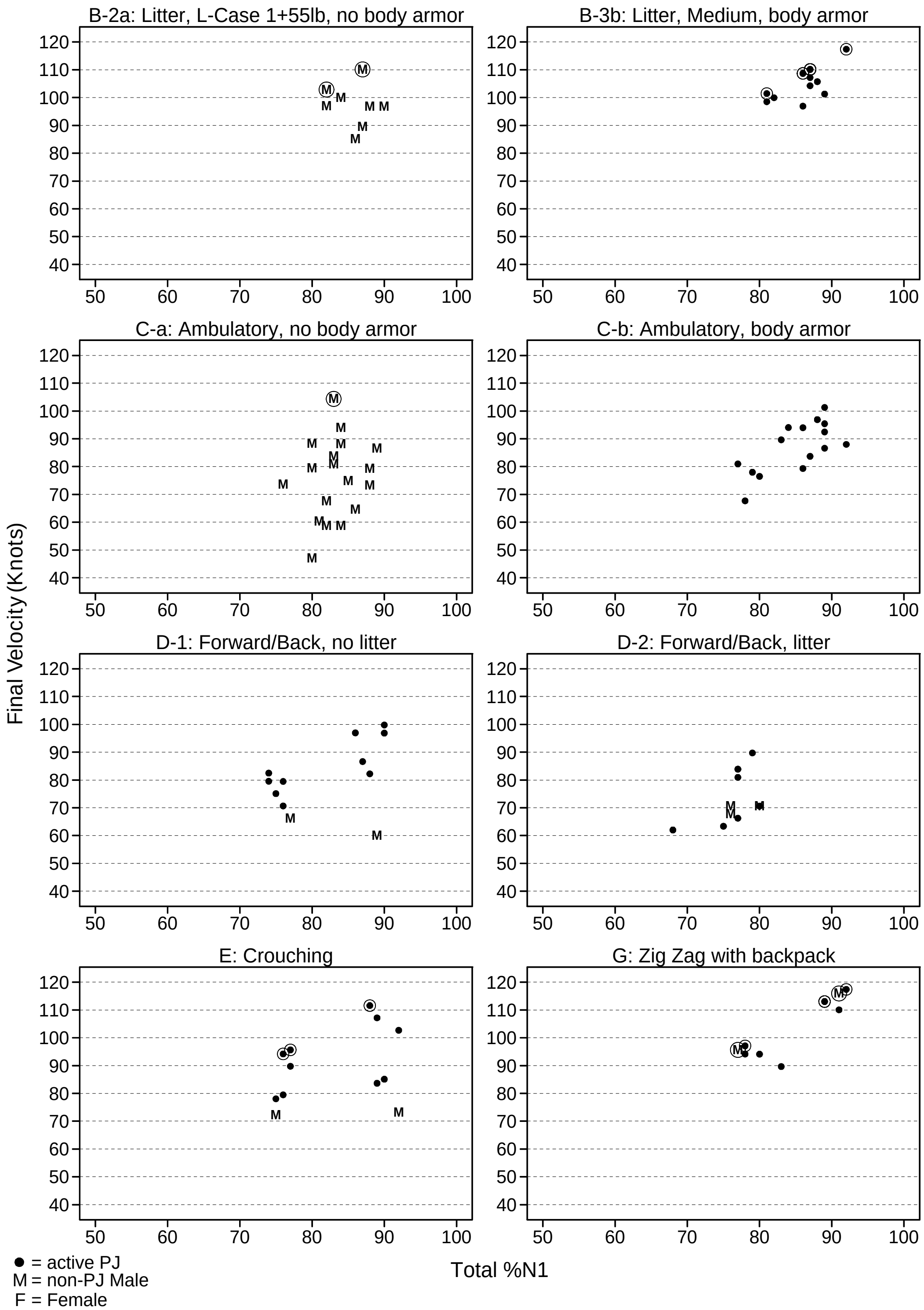

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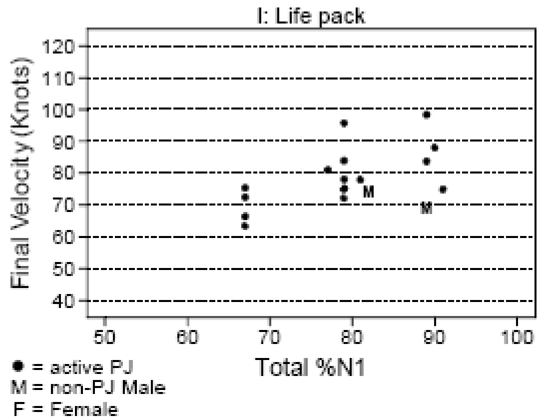

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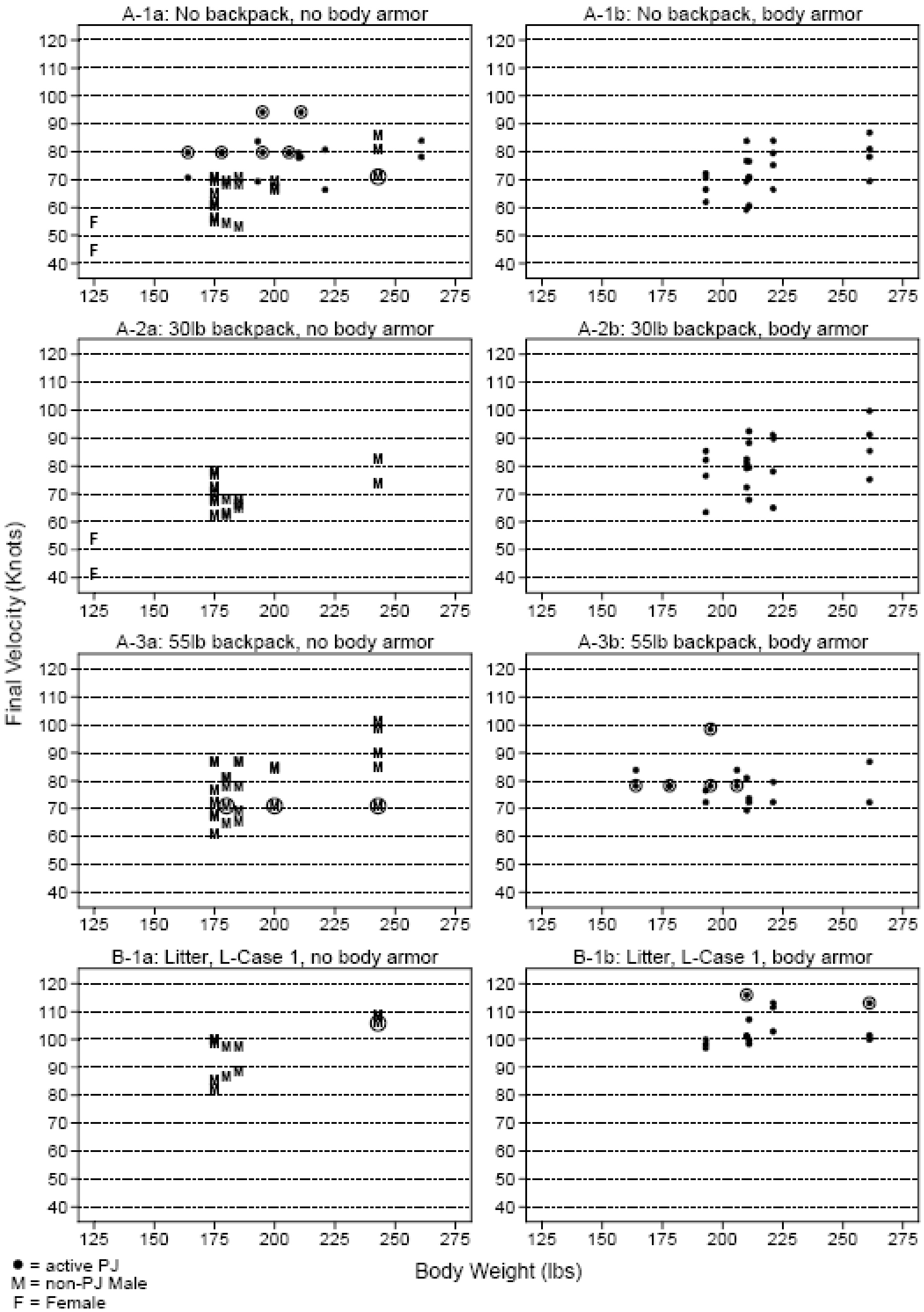

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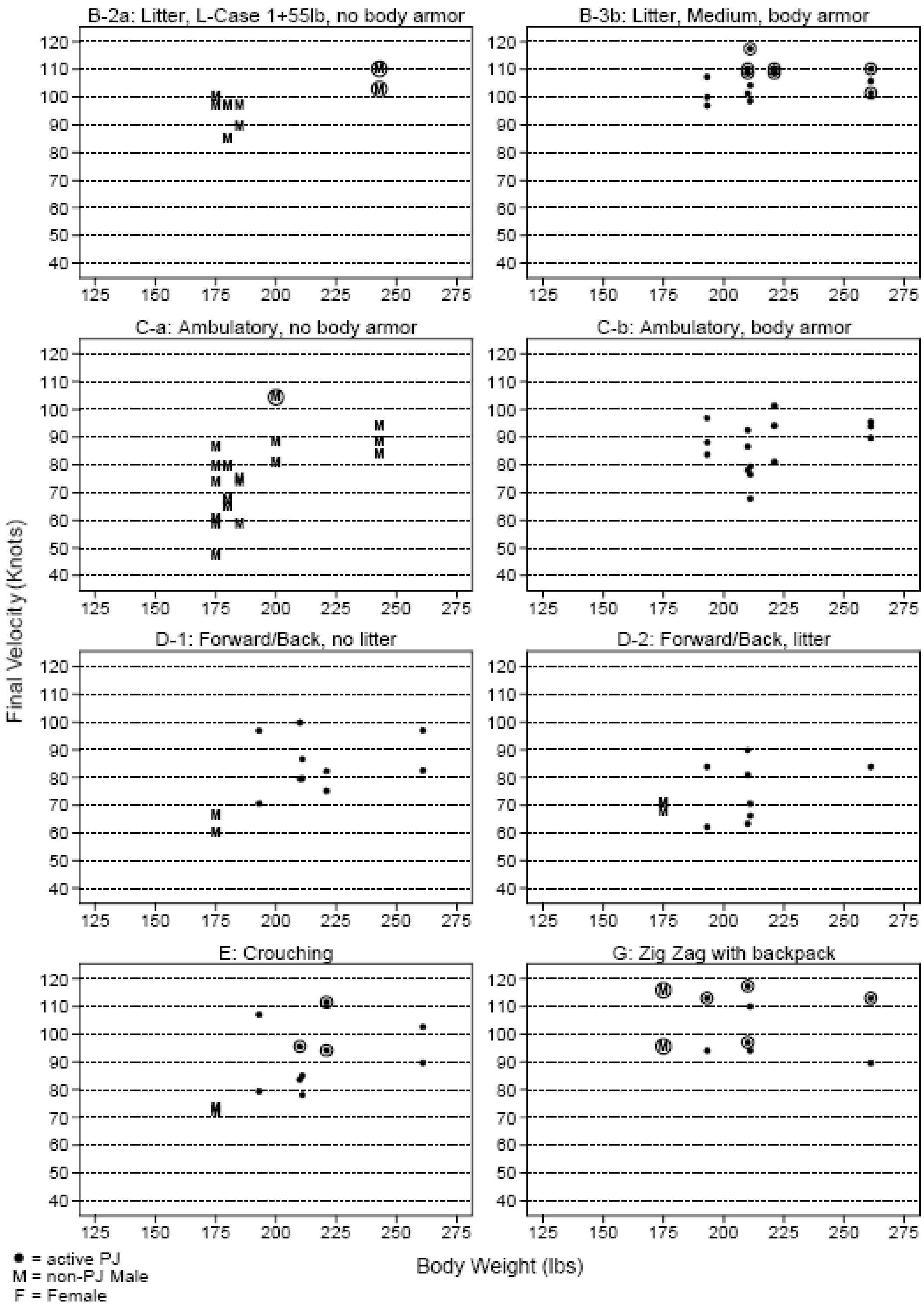
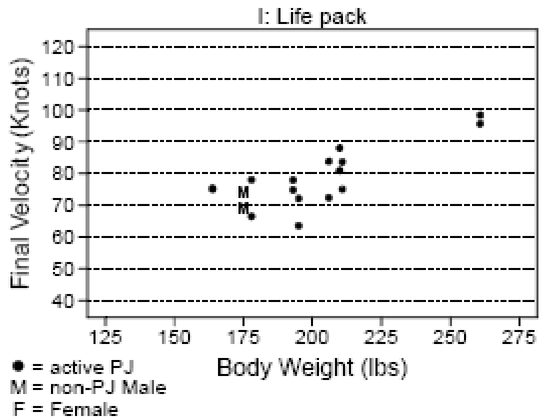


Final velocity for each cell, subject, and replication. PJ-1 was considered a non-PJ male. Final velocities with a final position = 5 ft are circled.



Final velocity for each cell, subject, and replication. PJ-1 was considered a non-PJ male. Final velocities with a final position = 5 ft are circled.

Test Number	Cell	Nominal Exit Velocity	Total Engine %N1	Subject1	Subject Type	Back pack Wt (lb)	Test Wt (lbs)	Body Armor	Subject2	Subject Type2	Back pack Wt2 (lb)	Patient	Surface Conditions	Date	Time	Temp (deg F)	Relative Humidity (%)	Baro Press (inHg)	Final Position (ft)	Final Velocity 3ft above ground
1	T-1a	60	60	PJ-1	Human-M	None	185	No	None	None	None	None	Wet	2/14/2005	931	57.1	66.2	28.78		
2	T-1a	80	71	PJ-1	Human-M	None	185	No	None	None	None	None	Wet	2/14/2005	929	55.3	67.5	28.78	11	69.32
3	T-1a	100	83	PJ-1	Human-M	None	185	No	None	None	None	None	Wet	2/14/2005	934	53.6	74.9	28.77	18	66.14
4	T-1a	60	60	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	938	54.6	72.2	28.77	8	62.19
5	T-1a	80	72	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	940	53.6	73.3	28.77	13	64.89
6	T-1a	100	84	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	941	53.3	73.8	28.77	14	79.35
7	T-1a	120	100	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	944	52.7	74.2	28.78	19	87.85
8	T-1b	60	60	S-39	Human-F	None	130	No	None	None	None	None	Wet	2/14/2005	951	53.5	74.8	28.77	10	56.31
9	T-1a	80	70	S-39	Human-F	None	130	No	None	None	None	None	Wet	2/14/2005	957	53.5	74.9	28.77	22	35.53
10	T-1a	60	60	P-14	Human-M	None	245	No	None	None	None	None	Wet	2/14/2005	1025	55	76.9	28.77	7	65.13
11	T-1a	80	73	P-14	Human-M	None	245	No	None	None	None	None	Wet	2/14/2005	1027	54.3	76.3	28.78	9	78.1
12	T-1a	100	85	P-14	Human-M	None	245	No	None	None	None	None	Wet	2/14/2005	1029	53.3	76.6	28.78	12	86.68
13	T-1a	80	70	P-14	Human-M	35	280	No	None	None	None	None	Wet	2/14/2005	1033	54.6	76.8	28.78	7	79.63
14	T-1a	100	85	PJ-5	Human-M	35	262	No	None	None	None	None	Wet	2/14/2005	1036	53.53	77.3	28.78	15	77.86
15	T-1b	80	72	PJ-1	Human-M	None	200	Yes	None	None	None	None	Wet	2/14/2005	1041	55.3	77	28.78	16	56.07
16	T-2b	80	70	PJ-1	Human-M	35	235	Yes	None	None	None	None	Wet	2/14/2005	1044	54.6	77.5	28.78	15	56.11
17	A-1a	80	75	PJ-1	Human-M	None	185	No	None	None	None	None	Wet	2/14/2005	1317	54	66.5	28.78	13	69.24
18	A-1a	100	90	R-27	Human-M	None	180	No	None	None	None	None	Wet	2/14/2005	1323	52	73	28.8	23	61.59
19	A-1a	80	74	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	1327	52.8	73.5	28.8	7	85.43
20	A-1a	60	60	S-39	Human-F	None	130	No	None	None	None	None	Wet	2/14/2005	1331	51.2	74.3	28.8	14	44.55
21	A-1a	80	74	R-27	Human-M	None	180	No	None	None	None	None	Wet	2/14/2005	1335	51.1	74	28.8	12	70.73
22	A-1a	100	83	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	1338	51.1	75	28.8	13	80.84
23	A-1a	60	60	PJ-1	Human-M	None	185	No	None	None	None	None	Wet	2/14/2005	1341	51.5	73.1	28.8	6	68.07
24	A-1a	60	60	R-27	Human-M	None	180	No	None	None	None	None	Wet	2/14/2005	1343	51.5	72.8	28.79	7	65.13
25	A-1a	60	60	SI-1	Human-M	None	248	No	None	None	None	None	Wet	2/14/2005	1345	51.5	72.8	28.8	5	71.01
26	A-1a	80	75	S-39	Human-F	None	130	No	None	None	None	None	Wet	2/14/2005	1348	51.4	72	28.8	18	54.54
27	A-1a	100	85	PJ-1	Human-M	None	185	No	None	None	None	None	Wet	2/14/2005	1357	51.4	72	28.8	23	54.34
28	A-1a	80	76	C-32	Human-M	None	190	No	None	None	None	None	Wet	2/14/2005	1402	51.5	72.6	28.8	13	70.69
28.1	A-1a	60	60	C-32	Human-M	None	190	No	None	None	None	None	Wet	2/14/2005	1409	51.9	75.2	28.8	6	68.07
29	A-1a	100	90	C-32	Human-M	None	190	No	None	None	None	None	Wet	2/14/2005	1406	51.4	79.2	28.8	26	52.77
30	A-2a	100	93	PJ-1	Human-M	35	220	No	None	None	None	None	Wet	2/14/2005	1425	51.5	74.6	28.81	24	63
31	A-2a	100	90	R-27	Human-M	35	215	No	None	None	None	None	Wet	2/14/2005	1431	50.3	78.2	28.81	21	67.47
32	A-2a	80	76	SI-1	Human-M	35	283	No	None	None	None	None	Wet	2/14/2005	1437	49.7	82	28.81	9	82.45
33	A-2a	60	60	C-32	Human-M	35	225	No	None	None	None	None	Wet	2/14/2005	1440	49.9	82	28.81	6	68.07

34	A-2a	60	60	S-39	Human-F	35	165	No	None	None	None	None	Wet	2/14/2005	1446	49.9	81	28.8	11	53.37
35	A-2a	60	60	PJ-1	Human-M	35	220	No	None	None	None	None	Wet	2/14/2005	1450	49	81	28.8	6	68.07
36	A-2a	60	60	R-27	Human-M	35	215	No	None	None	None	None	Wet	2/14/2005	1452	49.4	81	28.8	8	62.19
37	A-2a	100	92	SI-1	Human-M	35	283	No	None	None	None	None	Wet	2/14/2005	1457	50.2	80.3	28.83	20	73.31
38	A-2a	100	86	C-32	Human-M	35	225	No	None	None	None	None	Wet	2/14/2005	1500	49.9	78.8	28.83	20	64.61
39	A-2a	80	76	S-39	Human-M	35	165	No	None	None	None	None	Wet	2/14/2005	1507	49.5	85.1	28.84	23	41.29
40	A-2a	80	76	PJ-1	Human-M	35	220	No	None	None	None	None	Wet	2/14/2005	1510	47.9	88	28.84	16	61.87
41	A-2a	80	80	R-27	Human-M	35	215	No	None	None	None	None	Wet	2/14/2005	1514	47.2	89.5	28.84	15	70.61
43	A-2a	80	79	C-32	Human-M	35	225	No	None	None	None	None	Dry	2/15/2005	851	49.4	67	29.15	16	66.22
44	A-1a	60	59	M-47	Human-M	None	205	No	None	None	None	None	Dry	2/15/2005	858	49.7	67	29.15	6	66.62
45	A-3a	60	57	R-27	Human-M	60	240	No	None	None	None	None	Dry	2/15/2005	902	50.6	66.2	29.15	7	60.78
46	A-1a	100	93	M-47	Human-M	None	205	No	None	None	None	None	Dry	2/15/2005	907	50.9	65.8	29.15	23	65.94
47	A-3a	80	79	SI-1	Human-M	60	308	No	None	None	None	None	Dry	2/15/2005	910	51	65	29.15	8	88.74
48	A-1a	80	79	M-47	Human-M	None	205	No	None	None	None	None	Dry	2/15/2005	912	52	64.6	29.15	15	69.16
49	A-3a	80	80	PJ-1	Human-M	60	245	No	None	None	None	None	Dry	2/15/2005	917	51.8	64.2	29.15	17	64.73
50	A-3a	60	60	M-47	Human-M	60	265	No	None	None	None	None	Dry	2/15/2005	921	52.2	63.7	29.15	5	71.01
51	A-3a	60	60	C-32	Human-M	60	250	No	None	None	None	None	Dry	2/15/2005	923	52.3	64	29.15	7	65.13
52	A-3a	80	80	R-27	Human-M	60	240	No	None	None	None	None	Dry	2/15/2005	926	52.6	61.2	29.15	16	67.67
53	A-3a	60	60	SI-1	Human-M	60	308	No	None	None	None	None	Dry	2/15/2005	928	52.6	62.5	29.15	5	71.01
54	A-3a	80	79	M-47	Human-M	60	265	No	None	None	None	None	Dry	2/15/2005	931	52.8	61.3	29.15	10	83.86
55	A-3a	100	99	PJ-1	Human-M	60	245	No	None	None	None	None	Dry	2/15/2005	935	53.5	61.2	29.14	22	77.58
56	A-3a	80	77	C-32	Human-M	60	250	No	None	None	None	None	Dry	2/15/2005	938	53	61	29.14	11	78.02
57	A-3a	100	98	R-27	Human-M	60	240	No	None	None	None	None	Dry	2/15/2005	942	53.2	60.5	29.14	25	67.31
58	A-3a	100	96	M-47	Human-M	60	265	No	None	None	None	None	Dry	2/15/2005	945	53.5	60.7	29.14	18	84.99
59	A-3a	100	94	SI-1	Human-M	60	308	No	None	None	None	None	Dry	2/15/2005	949	54.3	59.2	29.14	17	85.03
60	A-3a	60	60	PJ-1	Human-M	60	245	No	None	None	None	None	Dry	2/15/2005	952	54.7	58.4	29.14	5	71.01
61	A-3a	100	95	C-32	Human-M	60	250	No	None	None	None	None	Dry	2/15/2005	955	54.8	58.1	29.14	23	68.84
62	C-a	80	82	C-32	Human-M	None	190	No	None	None	None	PJ-1	Dry	2/15/2005	1323	63.7	45.5	29.06	20	58.81
63	C-a	80	80	R-27	Human-M	None	180	No	None	None	None	S-39	Dry	2/15/2005	1328	63.9	42.4	29.05	23	47.09
64	C-a	80	82	PJ-1	Human-M	None	185	No	None	None	None	R-27	Dry	2/15/2005	1333	64	42	29.05	17	67.63
65	C-a	80	80	M-47	Human-M	None	205	No	None	None	None	C-32	Dry	2/15/2005	1337	64.4	42	29.05	9	88.25
66	C-a	80	84	SI-1	Human-M	None	248	No	None	None	None	M-47	Dry	2/15/2005	1341	64	42.6	29.05	11	88.17
67	C-a	80	84	R-27	Human-M	None	180	No	None	None	None	PJ-1	Dry	2/15/2005	1345	65	40.9	29.05	21	58.77
68	C-a	80	86	PJ-1	Human-M	None	185	No	None	None	None	C-32	Dry	2/15/2005	1348	64.6	41.2	29.05	20	64.61
69	C-a	80	88	C-32	Human-M	None	190	No	None	None	None	S-39	Dry	2/15/2005	1351	65.1	42	29.04	18	73.39
70	C-a	80	83	M-47	Human-M	None	205	No	None	None	None	SI-1	Dry	2/15/2005	1354	64.9	40.8	29.04	13	80.84
71	C-a	80	83	SI-1	Human-M	None	248	No	None	None	None	PJ-1	Dry	2/15/2005	1357	64.9	40.8	29.04	12	83.78
72	C-a	80	81	R-27	Human-M	None	180	No	None	None	None	M-47	Dry	2/15/2005	1359	65	39.6	29.04	19	60.3
73	C-a	80	88	PJ-1	Human-M	None	185	No	None	None	None	SI-1	Dry	2/15/2005	1402	65.1	38.4	29.04	16	79.27
74	C-a	80	84	SI-1	Human-M	None	248	No	None	None	None	S-39	Dry	2/15/2005	1404	65.1	38.9	29.04	9	94.05
75	C-a	80	83	M-47	Human-M	None	205	No	None	None	None	R-27	Dry	2/15/2005	1407	65.1	38.9	29.04	5	104.36
76	C-a	80	85	C-32	Human-M	None	190	No	None	None	None	M-47	Dry	2/15/2005	1410	65	37.6	29.03	16	74.92
77	B-1a	80	88	R-27	Human-M	None	180	No	PJ-1	Human-M	None	L-Case 1	Dry	2/16/2005	837	42.1	61.7	29.11	14	85.15
78	B-1a	80	89	PJ-1	Human-M	None	185	No	C-32	Human-M	None	L-Case 1	Dry	2/16/2005	840	41.3	66.4	29.12	14	86.6
79	B-1a	80	88	C-32	Human-M	None	190	No	SI-1	Human-M	None	L-Case 1	Dry	2/16/2005	843	40.2	68	29.12	13	88.09
80	B-1a	80	88	SI-1	Human-M	None	248	No	R-27	Human-M	None	L-Case 1	Dry	2/16/2005	845	39.5	68.4	29.12	6	108.67
81	B-1a	80	90	PJ-1	Human-M	None	185	No	R-27	Human-M	None	L-Case 1	Dry	2/16/2005	847	39.2	69.1	29.13	11	96.87
82	B-1a	80	84	R-27	Human-M	None	180	No	SI-1	Human-M	None	L-Case 1	Dry	2/16/2005	850	40	69.1	29.13	13	82.29
83	B-1a	80	88	C-32	Human-M	None	190	No	PJ-1	Human-M	None	L-Case 1	Dry	2/16/2005	853	39.9	70.2	29.13	10	96.91
84	B-1a	80	84	SI-1	Human-M	None	248	No	C-32	Human-M	None	L-Case 1	Dry	2/16/2005	857	38.8	72.2	29.13	5	105.81

85	B-2a	80	90	R-27	Human-M	None	180	No	PJ-1	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	902	39.3	73	29.13	11	96.87
86	B-2a	80	86	PJ-1	Human-M	None	185	No	C-32	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	904	39.5	72.7	29.13	13	85.19
87	B-2a	80	87	C-32	Human-M	None	190	No	SI-1	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	907	40.1	71.4	29.13	12	89.58
88	B-2a	80	82	SI-1	Human-M	None	248	No	R-27	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	909	40	71.3	29.13	5	102.91
89	B-2a	80	82	PJ-1	Human-M	None	185	No	R-27	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	911	40	70.9	29.13	7	97.03
90	B-2a	80	84	R-27	Human-M	None	180	No	SI-1	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	914	39.9	70.4	29.13	7	99.93
91	B-2a	80	88	C-32	Human-M	None	190	No	PJ-1	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	917	39.6	71.3	29.13	10	96.91
92	B-2a	80	87	SI-1	Human-M	None	248	No	C-32	Human-M	None	L-Case 1+55lb	Dry	2/16/2005	919	39.9	71.4	29.13	5	110.16
93	A-3a	80	77	PJ-1	Human-M	60	245	No	None	None	None	None	Dry	2/16/2005	953	39.7	70.5	29.14	10	80.96
94	A-3a	100	89	PJ-1	Human-M	60	245	No	None	None	None	None	Dry	2/16/2005	955	39.7	70.5	29.14	16	80.72
95	A-3a	80	81	R-27	Human-M	60	240	No	None	None	None	None	Dry	2/16/2005	958	40	74.3	29.14	10	86.76
96	A-3a	100	89	R-27	Human-M	60	240	No	None	None	None	None	Dry	2/16/2005	959	40	74.3	29.14	14	86.6
97	A-3a	80	81	SI-1	Human-M	60	308	No	None	None	None	None	Dry	2/16/2005	1003	39.3	69.2	29.14	6	98.52
98	A-3a	100	89	SI-1	Human-M	60	308	No	None	None	None	None	Dry	2/16/2005	1004	39.3	69.2	29.14	9	101.3
99	A-3a	80	81	C-32	Human-M	60	250	No	None	None	None	None	Dry	2/16/2005	1007	39.3	70.4	29.14	10	86.76
100	A-3a	100	89	C-32	Human-M	60	250	No	None	None	None	None	Dry	2/16/2005	1009	39.3	70.4	29.14	14	86.6
101	T-1a	60	60	GT	Human-M	None	180	No	None	None	None	None	Dry	3/7/2005	903	51.9	59	28.64	14	44.55
102	T-1a	80	65	GT	Human-M	None	180	No	None	None	None	None	Dry	3/7/2005	905	53.2	60	28.64	18	40.04
103	T-1b	100	73	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	906	53.2	60	28.64	17	54.58
104	T-1b	60	60	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	908	53.5	60.7	28.63	10	56.31
105	T-1b	80	65	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	910	53.4	60.4	28.63	10	63.56
106	T-1b	100	74	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	911	53.6	61.4	28.63	14	64.85
107	T-1b	60	60	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/7/2005	912	53.2	60.9	28.63	13	47.49
108	T-1b	80	66	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/7/2005	913	53.5	59	28.63	12	59.13
109	T-1b	100	75	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/7/2005	914	53.5	58.2	28.63	13	69.24
110	T-1b	60	60	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	915	53.5	58.8	28.63	9	59.25
111	T-1b	80	67	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	916	53.3	57.4	28.63	12	60.58
112	T-1b	100	75	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	916	53.5	58.2	28.62	12	72.18
113	T-1b	60	60	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/7/2005	917	53.4	58.1	28.62	11	53.37
114	T-1b	80	66	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/7/2005	918	53.2	58	28.62	11	62.07
115	T-1b	100	75	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/7/2005	919	53.5	58.3	28.62	11	75.12
116	T-1b	60	60	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/7/2005	920	53.5	58.5	28.63	8	62.19
117	T-1b	80	65	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/7/2005	921	53.6	58	28.63	8	69.44
118	T-1b	100	76	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/7/2005	922	53.6	57.7	28.63	10	79.51
119	T-2b	80	66	GT	Human-M	35	215	No	None	None	None	None	Dry	3/7/2005	924	53.5	57.4	28.63	12	59.13
120	T-2b	80	66	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/7/2005	927	52.3	59.6	28.63	12	59.13
121	T-2b	80	67	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/7/2005	930	53.2	59.4	28.64	12	60.58
122	T-2b	80	67	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/7/2005	932	53.9	58	28.62	8	72.34
123	T-2b	80	65	PJ-5	Human-M	35	277	Yes	None	None	None	None	Dry	3/7/2005	934	53.6	59	28.63	10	63.56
124	T-2b	80	67	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/7/2005	935	54	57.6	28.62	9	69.4
125	A-1b	80	68	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	1002	55	57.1	28.62	12	62.03
126	A-1b	60	67	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	1004	54.9	58	28.62	12	60.58
127	A-1b	80	63	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/7/2005	1005	55	56.3	28.62	7	69.48
128	A-1a	80	66	GT	Human-M	None	180	No	None	None	None	None	Dry	3/7/2005	1006	55.3	58	28.62	13	56.19
129	A-1b	100	74	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	1007	55.6	56.8	28.62	12	70.73
130	A-1b	80	66	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/7/2005	1008	55.5	57	28.62	12	59.13
131	A-1b	100	74	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/7/2005	1009	55.3	57.1	28.62	12	70.73

132	A-1b	80	67	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/7/2005	1010	55.8	62.2	28.62	10	66.46
133	A-1b	100	77	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/7/2005	1011	55.5	57.9	28.61	10	80.96
134	A-1a	100	75	GT	Human-M	None	180	No	None	None	None	None	Dry	3/7/2005	1012	55.4	57.7	28.61	13	69.24
135	A-1b	100	75	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/7/2005	1013	55.4	57.6	28.61	13	69.24
136	A-1b	100	78	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/7/2005	1014	56.1	56.5	28.61	11	79.47
137	A-2b	80	67	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/7/2005	1016	55.7	56.3	28.61	11	63.52
138	A-2b	80	68	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/7/2005	1018	55.4	57.8	28.61	10	67.91
139	A-2b	80	67	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/7/2005	1020	55.7	57.1	28.6	7	75.28
140	A-2a	80	70	GT	Human-M	35	215	No	None	None	None	None	Dry	3/7/2005	1021	56.1	56.9	28.61	11	67.87
141	A-2b	100	76	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/7/2005	1023	55.3	57.3	28.61	11	76.57
142	A-2b	80	67	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/7/2005	1024	55.7	57.1	28.61	8	72.34
143	A-2b	100	76	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/7/2005	1026	55.9	56.6	28.61	10	79.51
144	A-2b	80	66	PJ-5	Human-M	35	277	Yes	None	None	None	None	Dry	3/7/2005	1028	55.7	56.5	28.61	10	65.01
145	A-2b	100	74	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/7/2005	1029	55.9	56.8	28.61	7	85.43
146	A-2a	100	75	GT	Human-M	35	215	No	None	None	None	None	Dry	3/7/2005	1031	56.1	56.4	28.6	12	72.18
147	A-2b	100	79	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/7/2005	1033	56.1	56.4	28.6	11	80.82
148	A-2b	100	75	PJ-5	Human-M	35	277	Yes	None	None	None	None	Dry	3/7/2005	1034	56.1	56.4	28.6	10	78.06
149	A-3b	80	69	PJ-2	Human-M	60	291	Yes	None	None	None	None	Dry	3/7/2005	1037	55.7	56.5	28.6	9	72.3
150	A-3b	80	67	PJ-4	Human-M	60	291	Yes	None	None	None	None	Dry	3/7/2005	1038	55.6	57.1	28.6	8	72.34
151	A-3b	80	67	PJ-6	Human-M	60	360	Yes	None	None	None	None	Dry	3/7/2005	1040	55.4	57.7	28.6	8	72.34
152	A-3a	80	67	GT	Human-M	60	240	No	None	None	None	None	Dry	3/7/2005	1042	55.4	57.7	28.6	8	72.34
153	A-3b	100	74	PJ-2	Human-M	60	291	Yes	None	None	None	None	Dry	3/7/2005	1043	55.7	57.3	28.6	10	76.61
154	A-3b	80	67	PJ-3	Human-M	60	293	Yes	None	None	None	None	Dry	3/7/2005	1045	55.8	57.4	28.6	9	69.4
155	A-3b	100	74	PJ-4	Human-M	60	291	Yes	None	None	None	None	Dry	3/7/2005	1046	56.2	56.2	28.59	11	73.67
156	A-3b	80	69	PJ-5	Human-M	60	302	Yes	None	None	None	None	Dry	3/7/2005	1048	56.2	56.8	28.6	9	72.3
157	A-3b	100	75	PJ-6	Human-M	60	360	Yes	None	None	None	None	Dry	3/7/2005	1049	56.4	56.8	28.6	7	86.88
158	A-3a	100	74	GT	Human-M	60	240	No	None	None	None	None	Dry	3/7/2005	1051	56.7	566.4	28.6	10	76.61
159	A-3b	100	75	PJ-3	Human-M	60	293	Yes	None	None	None	None	Dry	3/7/2005	1053	56.6	56.7	28.59	9	81
160	A-3b	100	74	PJ-5	Human-M	60	302	Yes	None	None	None	None	Dry	3/7/2005	1054	56.7	56.7	28.6	9	79.55
161	B-1a	120	90	GT	Human-M	None	180	No	PJ-6	Human-M	60	L-Case 1	Dry	3/7/2005	1323	56.5	56.5	28.55	10	89.81
162	B-1b	120	84	PJ-2	Human-M	None	231	Yes	GT	Human-M	60	L-Case 1	Dry	3/7/2005	1326	56.1	56.1	28.54	8	96.89
163	B-1b	120	89	PJ-3	Human-M	None	233	Yes	PJ-2	Human-M	60	L-Case 1	Dry	3/7/2005	1329	57	57	28.54	9	101.3
164	B-1b	120	88	PJ-4	Human-M	None	231	Yes	PJ-3	Human-M	60	L-Case 1	Dry	3/7/2005	1331	60.6	56	28.54	9	99.85
165	B-1b	120	90	PJ-5	Human-M	None	242	Yes	PJ-4	Human-M	60	L-Case 1	Dry	3/7/2005	1334	60.4	56.6	28.55	6	111.57
166	B-1b	120	82	PJ-6	Human-M	None	300	Yes	PJ-5	Human-M	60	L-Case 1	Dry	3/7/2005	1336	60.4	57.4	28.54	6	99.97
167	B-1a	120	90	GT	Human-M	None	180	No	PJ-2	Human-M	60	L-Case 1	Dry	3/7/2005	1340	60.4	56	28.54	10	88.81
168	B-1b	120	89	PJ-2	Human-M	None	231	Yes	PJ-3	Human-M	60	L-Case 1	Dry	3/7/2005	1343	62.1	55.6	28.53	10	98.36
169	B-1b	120	91	PJ-3	Human-M	None	233	Yes	PJ-4	Human-M	60	L-Case 1	Dry	3/7/2005	1346	61.1	55.2	28.53	10	101.26
170	B-1b	120	87	PJ-4	Human-M	None	231	Yes	PJ-5	Human-M	60	L-Case 1	Dry	3/7/2005	1348	60.8	55.8	28.53	9	98.4
171	B-1b	120	84	PJ-5	Human-M	None	242	Yes	PJ-6	Human-M	60	L-Case 1	Dry	3/7/2005	1350	60.6	55.4	28.53	6	102.87
172	B-1b	120	91	PJ-4	Human-M	None	231	Yes	GT	Human-M	60	L-Case 1	Dry	3/7/2005	1353	61.1	55.3	28.53	8	107.14
173	B-1b	120	91	PJ-5	Human-M	None	242	Yes	PJ-2	Human-M	60	L-Case 1	Dry	3/7/2005	1355	61.3	56	28.53	6	113.02
174	B-1a	120	91	GT	Human-M	None	180	No	PJ-4	Human-M	60	L-Case 1	Dry	3/7/2005	1358	61.4	56	28.53	11	98.32
175	B-1b	120	89	PJ-6	Human-M	None	300	Yes	PJ-3	Human-M	60	L-Case 1	Dry	3/7/2005	1400	61.6	55.9	28.53	5	113.06
176	B-1b	120	88	PJ-2	Human-M	None	231	Yes	PJ-5	Human-M	60	L-Case 1	Dry	3/7/2005	1402	61.3	55.7	28.53	9	99.85
177	B-1b	120	91	PJ-3	Human-M	None	233	Yes	PJ-6	Human-M	60	L-Case 1	Dry	3/7/2005	1404	61.9	55.2	28.53	5	115.96
178	B-1b	120	85	PJ-6	Human-M	None	300	Yes	GT	Human-M	60	L-Case 1	Dry	3/7/2005	1407	62.1	54.4	28.54	7	101.38

179	B-3a	120	82	GT	Human-M	None	180	No	PJ-6	Human-M	60	50%ile manikin	Dry	3/7/2005	1421	62.4	58	28.52	5	102.91
180	B-3b	120	87	PJ-2	Human-M	None	231	Yes	GT	Human-M	60	50%ile manikin	Dry	3/7/2005	1423	62.4	55.4	28.53	6	107.22
181	B-3b	120	89	PJ-3	Human-M	None	233	Yes	PJ-2	Human-M	60	50%ile manikin	Dry	3/7/2005	1425	61.8	55	28.53	9	101.3
182	B-3b	120	81	PJ-4	Human-M	None	231	Yes	PJ-3	Human-M	60	50%ile manikin	Dry	3/7/2005	1427	61.8	55.5	28.53	6	98.52
183	B-3b	120	86	PJ-5	Human-M	None	242	Yes	PJ-4	Human-M	60	50%ile manikin	Dry	3/7/2005	1429	61.7	56.3	28.52	5	108.71
184	B-3b	120	87	PJ-6	Human-M	None	300	Yes	PJ-5	Human-M	60	50%ile manikin	Dry	3/7/2005	1431	61.3	57.4	28.53	5	110.16
185	B-3a	120	87	GT	Human-M	None	180	No	PJ-2	Human-M	60	50%ile manikin	Dry	3/7/2005	1433	62.6	55.7	28.52	8	101.34
186	B-3b	120	86	PJ-2	Human-M	None	231	Yes	PJ-3	Human-M	60	50%ile manikin	Dry	3/7/2005	1435	61.6	55.9	28.52	9	96.95
187	B-3b	120	86	PJ-3	Human-M	None	233	Yes	PJ-4	Human-M	60	50%ile manikin	Dry	3/7/2005	1437	61.5	56.1	28.52	5	108.71
188	B-3b	120	92	PJ-4	Human-M	None	231	Yes	PJ-5	Human-M	60	50%ile manikin	Dry	3/7/2005	1439	61.8	55.3	28.52	5	117.41
189	B-3b	120	87	PJ-5	Human-M	None	242	Yes	PJ-6	Human-M	60	50%ile manikin	Dry	3/7/2005	1441	61.3	55.8	28.52	5	110.16
190	B-3b	120	87	PJ-4	Human-M	None	231	Yes	GT	Human-M	60	50%ile manikin	Dry	3/7/2005	1443	61.8	55.6	28.52	7	104.28
191	B-3b	120	87	PJ-5	Human-M	None	242	Yes	PJ-2	Human-M	60	50%ile manikin	Dry	3/7/2005	1447	62.3	56.2	28.52	5	110.16
192	B-3a	120	87	GT	Human-M	None	180	No	PJ-4	Human-M	60	50%ile manikin	Dry	3/7/2005	1449	62.3	57.4	28.52	6	107.22
193	B-3b	120	81	PJ-6	Human-M	None	300	Yes	PJ-3	Human-M	60	50%ile manikin	Dry	3/7/2005	1451	61.9	56	28.52	5	101.46
194	B-3b	120	82	PJ-2	Human-M	None	231	Yes	PJ-5	Human-M	60	50%ile manikin	Dry	3/7/2005	1453	62.1	55.6	28.52	6	99.97
195	B-3b	120	87	PJ-3	Human-M	None	233	Yes	PJ-6	Human-M	60	50%ile manikin	Dry	3/7/2005	1455	62.3	559	28.52	5	110.16
196	B-3b	120	88	PJ-6	Human-M	None	300	Yes	GT	Human-M	60	50%ile manikin	Dry	3/7/2005	1457	61.9	56.1	28.51	7	105.73
197	C-a	120	89	GT	Human-M	None	180	No	None	None	None	PJ-6	Dry	3/7/2005	1508	62.1	57.8	28.51	14	86.6
198	C-b	120	87	PJ-2	Human-M	None	231	Yes	None	None	None	PJ-1	Dry	3/7/2005	1511	62.7	55	28.51	14	83.7
199	C-b	120	89	PJ-3	Human-M	None	233	Yes	None	None	None	PJ-2	Dry	3/7/2005	1512	63.5	55.5	28.51	12	92.48
200	C-b	120	78	PJ-4	Human-M	None	231	Yes	None	None	None	PJ-3	Dry	3/7/2005	1513	62.7	55.8	28.51	15	67.71
201	C-b	120	77	PJ-5	Human-M	None	242	Yes	None	None	None	PJ-4	Dry	3/7/2005	1515	62.8	55	28.51	10	80.96
202	C-b	120	83	PJ-6	Human-M	None	300	Yes	None	None	None	PJ-5	Dry	3/7/2005	1515	62.3	54.1	28.51	10	89.66
203	C-a	120	76	GT	Human-M	None	180	No	None	None	None	PJ-2	Dry	3/7/2005	1517	61.9	56	28.51	12	73.63
204	C-b	120	92	PJ-2	Human-M	None	231	Yes	None	None	None	PJ-3	Dry	3/7/2005	1518	61.9	56	28.51	15	88.01
205	C-b	120	89	PJ-3	Human-M	None	233	Yes	None	None	None	PJ-4	Dry	3/7/2005	1520	61.9	56.2	28.51	14	86.6
206	C-b	120	86	PJ-4	Human-M	None	231	Yes	None	None	None	PJ-5	Dry	3/7/2005	1521	61.5	56.6	28.51	15	79.31
207	C-b	120	89	PJ-5	Human-M	None	242	Yes	None	None	None	PJ-6	Dry	3/7/2005	1522	62.3	54.9	28.51	9	101.3
208	C-b	120	80	PJ-4	Human-M	None	231	Yes	None	None	None	PJ-1	Dry	3/7/2005	1524	61.9	55.1	28.51	13	76.49
209	C-b	120	84	PJ-5	Human-M	None	242	Yes	None	None	None	PJ-2	Dry	3/7/2005	1525	61.9	53.5	28.5	9	94.05
210	C-a	120	80	GT	Human-M	None	180	No	None	None	None	PJ-4	Dry	3/7/2005	1526	61.5	56.1	28.51	12	79.43
211	C-b	120	86	PJ-6	Human-M	None	300	Yes	None	None	None	PJ-3	Dry	3/7/2005	1527	61.5	56.2	28.51	10	94.01
212	C-b	120	88	PJ-2	Human-M	None	231	Yes	None	None	None	PJ-5	Dry	3/7/2005	1529	61.6	55.9	28.51	10	96.91
213	C-b	120	79	PJ-3	Human-M	None	233	Yes	None	None	None	PJ-6	Dry	3/7/2005	1530	61.5	56	28.51	12	77.98
214	C-b	120	89	PJ-6	Human-M	None	300	Yes	None	None	None	PJ-1	Dry	3/7/2005	1531	61.1	56	28.51	11	95.42
215	A-1a	100	69	PJ-2	Human-M	None	216	No	None	None	None	None	Dry	3/8/2005	937	29.4	57.3	28.88	10	69.36
216	A-1a	100	69	PJ-4	Human-M	None	216	No	None	None	None	None	Dry	3/8/2005	938	29.4	57.3	28.88	7	78.18
217	A-1a	100	69	PJ-6	Human-M	None	285	No	None	None	None	None	Dry	3/8/2005	939	29.4	57.3	28.88	7	78.18
218	A-1a	100	69	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	939	29.4	57.3	28.88	15	54.66
219	A-1a	120	87	PJ-2	Human-M	None	216	No	None	None	None	None	Dry	3/8/2005	941	29.4	57.3	28.88	14	83.7
220	A-1a	100	74	PJ-3	Human-M	None	218	No	None	None	None	None	Dry	3/8/2005	943	29.9	57.3	28.88	9	79.55
221	A-1a	120	76	PJ-4	Human-M	None	216	No	None	None	None	None	Dry	3/8/2005	944	29.1	56.1	28.88	5	94.21
222	A-1a	100	73	PJ-5	Human-M	None	227	No	None	None	None	None	Dry	3/8/2005	946	28	56.1	28.88	13	66.34
223	A-1a	120	75	PJ-6	Human-M	None	285	No	None	None	None	None	Dry	3/8/2005	947	28.9	55.8	28.88	8	83.94
224	A-1a	120	83	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	949	28.9	55.8	28.88	20	60.26
225	A-1a	120	83	PJ-3	Human-M	None	218	No	None	None	None	None	Dry	3/8/2005	950	28.9	55.8	28.88	14	77.9

226	A-1a	120	87	PJ-5	Human-M	None	227	No	None	None	None	None	Dry	3/8/2005	951	28.2	28.2	28.88	15	80.76
227	A-1b	100	67	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	953	28.9	28.2	28.88	10	66.46
228	A-1b	100	70	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	954	30.6	28.2	28.88	10	70.81
229	A-1b	100	69	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/8/2005	955	29.1	28.2	28.88	7	78.18
230	A-1a	100	71	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	956	29.1	28.2	28.88	14	60.5
231	A-1b	120	77	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	957	29.1	28.2	28.88	13	72.14
232	A-1b	100	70	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/8/2005	958	29.5	28.2	28.88	8	76.69
233	A-1b	120	76	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	959	28.2	28.2	28.88	11	76.57
234	A-1b	100	71	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/8/2005	1000	29.8	28.2	28.88	9	75.2
235	A-1b	120	77	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/8/2005	1001	29.1	28.2	28.88	8	86.84
236	A-1a	120	78	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	1001	28.1	28.2	28.88	14	70.65
237	A-1b	120	77	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/8/2005	1002	28.5	28.2	28.88	9	83.9
238	A-1b	120	77	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/8/2005	1003	28.9	57.1	28.88	9	83.9
239	A-2b	100	76	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/8/2005	1034	38	57.1	28.89	8	85.39
240	A-2b	100	76	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/8/2005	1035	37.1	36.43	28.89	7	88.33
241	A-2b	100	76	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/8/2005	1036	33.9	36.43	28.89	6	91.27
242	A-2a	100	76	GT	Human-M	35	215	No	None	None	None	None	Dry	3/8/2005	1036	35.5	36.43	28.89	11	76.57
243	A-2b	120	88	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/8/2005	1037	35.3	38.7	28.89	15	82.21
244	A-2b	100	76	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/8/2005	1039	33.4	39.9	28.89	9	82.45
245	A-2b	120	89	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/8/2005	1040	31.3	41	28.89	12	92.48
246	A-2b	100	75	PJ-5	Human-M	35	277	Yes	None	None	None	None	Dry	3/8/2005	1041	30.7	41	28.89	6	89.82
247	A-2b	120	88	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/8/2005	1042	30.1	41	28.89	8	99.85
248	A-2a	120	89	GT	Human-M	35	215	No	None	None	None	None	Dry	3/8/2005	1043	31	41	28.89	17	77.78
249	A-2b	120	90	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/8/2005	1044	30.5	41	28.89	17	79.23
250	A-2b	120	80	PJ-5	Human-M	35	277	Yes	None	None	None	None	Dry	3/8/2005	1045	29.9	41	28.89	8	91.19
251	D-1	100	76	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1046	30.4	41	28.89	13	70.69
252	D-1	100	74	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1046	30.9	41	28.89	9	79.55
253	D-1	100	74	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/8/2005	1047	30.9	41	28.89	8	82.49
254	D-1	100	77	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	1048	30.9	41	28.89	15	66.26
255	D-1	120	90	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1049	30.9	41	28.89	11	96.87
256	D-1	100	76	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/8/2005	1050	30.5	41	28.89	10	79.51
257	D-1	120	87	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1051	30.3	43.3	28.89	13	86.64
258	D-1	100	75	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/8/2005	1052	30.9	43.3	28.89	11	75.12
259	D-1	120	86	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/8/2005	1053	30.1	43.3	28.89	9	96.95
260	D-1	120	88	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	1054	29.6	43.3	28.89	23	60.14
261	D-1	120	80	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/8/2005	1055	30.4	43.3	28.89	10	99.81
262	D-1	120	88	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/8/2005	1057	33.8	43.3	28.89	15	82.21
263	E	100	76	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1058	33.2	43.3	28.89	10	79.51
264	E	100	75	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1059	32.6	43.3	28.89	10	78.06
265	E	100	77	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/8/2005	1100	31.9	43.3	28.89	7	89.78
266	E	100	75	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	1101	31.9	41.9	28.9	12	72.18
267	E	120	89	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1103	31.3	41.9	28.9	7	107.18
268	E	100	77	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/8/2005	1104	30.7	41.9	28.9	5	95.66
269	E	120	90	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/8/2005	1105	31.3	41.9	28.9	15	85.11
270	E	100	76	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/8/2005	1106	31.5	41.9	28.9	5	94.21
271	E	120	92	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/8/2005	1108	30.9	41.9	28.9	10	102.71
272	E	120	92	GT	Human-M	None	180	No	None	None	None	None	Dry	3/8/2005	1109	30.6	41.9	28.9	20	73.31

273	E	120	89	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/8/2005	1110	30.7	41.9	28.9	15	83.66
274	E	120	88	PJ-5	Human-M	None	242	Yes	None	None	None	None	Dry	3/8/2005	1111	30.9	41.9	28.9	5	111.61
275	D-2	100	80	GT	Human-M	None	180	No	None	None	None	PJ-6	Dry	3/9/2005	914	27	46.5	29.13	15	70.61
276	D-2	100	68	PJ-2	Human-M	None	231	Yes	None	None	None	PJ-1	Dry	3/9/2005	915	28	45	29.13	12	62.03
277	D-2	100	77	PJ-3	Human-M	None	233	Yes	None	None	None	PJ-2	Dry	3/9/2005	917	28	45	29.13	10	80.96
278	D-2	100	80	PJ-4	Human-M	None	231	Yes	None	None	None	PJ-3	Dry	3/9/2005	918	28	45	29.13	15	70.61
281	D-2	100	76	GT	Human-M	None	180	No	None	None	None	PJ-2	Dry	3/9/2005	920	28	44	29.13	14	67.75
282	D-2	100	77	PJ-2	Human-M	None	231	Yes	None	None	None	PJ-3	Dry	3/9/2005	921	28	44	29.13	9	83.9
283	D-2	100	75	PJ-3	Human-M	None	233	Yes	None	None	None	PJ-4	Dry	3/9/2005	922	28	44	29.13	15	63.36
286	D-2	100	77	PJ-4	Human-M	None	231	Yes	None	None	None	PJ-1	Dry	3/9/2005	923	27.7	47	29.13	15	66.26
288	D-2	100	76	GT	Human-M	None	180	No	None	None	None	PJ-4	Dry	3/9/2005	925	27.7	47	29.13	13	70.69
289	D-2	100	78	PJ-6	Human-M	None	300	Yes	None	None	None	PJ-3	Dry	3/8/2005	929	27.7	47	29.13		
291	D-2	100	79	PJ-3	Human-M	None	233	Yes	None	None	None	PJ-6	Dry	3/8/2005	926	27.7	47	29.13	8	89.74
292	D-2	100	77	PJ-6	Human-M	None	300	Yes	None	None	None	PJ-1	Dry	3/9/2005	927	27.7	47	29.13	9	83.9
293	F-1		79	GT	Human-M	None	180	No	None	None	None	None	Dry	3/9/2005	931	27.7	47	29.13		
294	F-1		79	PJ-2	Human-M	None	231	Yes	None	None	None	None	Dry	3/9/2005	933	27.7	47	29.13		
295	F-1		78	PJ-3	Human-M	None	233	Yes	None	None	None	None	Dry	3/9/2005	935	27	45	29.13		
296	F-1		78	PJ-4	Human-M	None	231	Yes	None	None	None	None	Dry	3/9/2005	938	27	45	29.13		
298	F-1		78	PJ-6	Human-M	None	300	Yes	None	None	None	None	Dry	3/9/2005	939	27	45	29.13		
299	F-2		81	GT	Human-M	35	215	No	None	None	None	None	Dry	3/9/2005	942	27	45	29.13		
300	F-2		82	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/9/2005	945	27	45	29.13		
301	F-2		90	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/9/2005	948	27	45	29.13		
302	F-2		88	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/9/2005	951	27	45	29.13		
304	F-2		90	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/9/2005	954	29	44	29.12		
305	G	100	80	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/9/2005	1038	29	44	29.12	7	94.13
306	G	100	78	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/9/2005	1040	29	44	29.12	6	94.17
307	G	100	83	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/9/2005	1042	29	44	29.12	10	89.66
308	G	100	77	GT	Human-M	35	230	Yes	None	None	None	None	Dry	3/9/2005	1044	34	33	29.12	5	95.66
309	G	120	89	PJ-2	Human-M	35	266	Yes	None	None	None	None	Dry	3/9/2005	1046	34	33	29.12	5	113.06
310	G	100	78	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/9/2005	1047	34	33	29.12	5	97.11
311	G	120	91	PJ-4	Human-M	35	266	Yes	None	None	None	None	Dry	3/9/2005	1049	33	36	29.11	7	110.08
313	G	120	89	PJ-6	Human-M	35	335	Yes	None	None	None	None	Dry	3/9/2005	1051	33	36	29.11	5	113.06
314	G	120	91	GT	Human-M	35	230	Yes	None	None	None	None	Dry	3/9/2005	1053	33	36	29.11	5	115.96
315	G	120	92	PJ-3	Human-M	35	268	Yes	None	None	None	None	Dry	3/8/2005	1055	33	36	29.11	5	117.41
317	H	100	76	GT	Human-M	35	230	Yes	None	None	None	PJ-6	Dry	3/9/2005	1057	33	36	29.11		
318	H	100	78	PJ-2	Human-M	35	266	Yes	None	None	None	PJ-1	Dry	3/9/2005	1100	33	36	29.11		
319	H	100	80	PJ-3	Human-M	35	268	Yes	None	None	None	PJ-2	Dry	3/9/2005	1102	33	36	29.11		
320	H	100	76	PJ-4	Human-M	35	266	Yes	None	None	None	PJ-3	Dry	3/9/2005	1104	32	37	29.11		
323	H	100	79	GT	Human-M	35	230	Yes	None	None	None	PJ-2	Dry	3/9/2005	1105	32	37	29.11		
324	H	100	81	PJ-2	Human-M	35	266	Yes	None	None	None	PJ-3	Dry	3/9/2005	1107	32	37	29.11		
325	H	100	78	PJ-3	Human-M	35	268	Yes	None	None	None	PJ-4	Dry	3/9/2005	1109	32	37	29.11		
328	H	100	80	PJ-4	Human-M	35	266	Yes	None	None	None	PJ-1	Dry	3/9/2005	1111	32	37	29.11		
330	H	100	81	GT	Human-M	35	230	Yes	None	None	None	PJ-4	Dry	3/9/2005	1113	32	37	28.11		
331	H	100	78	PJ-6	Human-M	35	335	Yes	None	None	None	PJ-3	Dry	3/9/2005	1115	32	37	28.11		
333	H	100	78	PJ-3	Human-M	35	268	Yes	None	None	None	PJ-6	Dry	3/9/2005	1117	33	39	29.11		
334	H	100	79	PJ-6	Human-M	35	335	Yes	None	None	None	PJ-1	Dry	3/9/2005	1120	33	39	29.11		
335	I	100	81	PJ-2	Human-M	35	296	Yes	None	None	None	None	Dry	3/9/2005	1122	33	39	29.11	13	77.94

336	I	100	79	PJ-4	Human-M	35	296	Yes	None	None	None	None	Dry	3/9/2005	1124	33	39	29.11	13	75.04
337	I	100	79	PJ-6	Human-M	35	365	Yes	None	None	None	None	Dry	3/9/2005	1125	33	39	29.11	6	95.62
338	I	100	82	GT	Human-M	35	245	No	None	None	None	None	Dry	3/9/2005	1127	33	39	29.11	15	73.51
339	I	120	81	PJ-2	Human-M	35	296	Yes	None	None	None	None	Dry	3/9/2005	1128	33	39	29.11	19	74.8
340	I	100	77	PJ-3	Human-M	35	298	Yes	None	None	None	None	Dry	3/9/2005	1130	33	38	29.11	10	80.96
341	I	120	89	PJ-4	Human-M	35	296	Yes	None	None	None	None	Dry	3/9/2005	1131	33	38	29.11	15	83.66
343	I	120	89	PJ-6	Human-M	35	365	Yes	None	None	None	None	Dry	3/9/2005	1133	33	38	29.11	10	98.36
344	I	120	89	GT	Human-M	35	245	No	None	None	None	None	Dry	3/9/2005	1135	33	38	29.11	20	66.96
345	I	120	90	PJ-3	Human-M	35	298	Yes	None	None	None	None	Dry	3/9/2005	1136	33	38	29.11	14	88.05
447	A-1a	100	66	PJ-7	Human-M	No	178	No	None	None	None	None	Dry	4/20/2005	1044	73	44	29.97	5	79.71
448	A-1a	100	66	PJ-8	Human-M	No	194	No	None	None	None	None	Dry	4/20/2005	1046	73	44	29.97	5	79.71
449	A-1a	100	66	PJ-9	Human-M	No	219	No	None	None	None	None	Dry	4/20/2005	1048	73	44	29.97	5	79.71
450	A-1a	100	66	PJ-10	Human-M	No	217	No	None	None	None	None	Dry	4/20/2005	1050	73	44	29.97	5	79.71
452	A-1a	120	74	PJ-7	Human-M	No	178	No	None	None	None	None	Dry	4/20/2005	1050	73	44	29.97	12	70.73
453	A-1a	120	74	PJ-8	Human-M	No	184	No	None	None	None	None	Dry	4/20/2005	1051	73	44	29.97	9	79.55
454	A-1a	120	76	PJ-9	Human-M	No	218	No	None	None	None	None	Dry	4/20/2005	1052	73	44	29.97	5	94.21
455	A-1a	120	76	PJ-10	Human-M	No	217	No	None	None	None	None	Dry	4/20/2005	1052	73	44	29.97	10	79.51
457	A-3b	100	65	PJ-7	Human-M	35	228	Yes	None	None	None	None	Dry	4/20/2005	1057	73	44	29.97	5	78.26
458	A-3b	100	65	PJ-8	Human-M	35	244	Yes	None	None	None	None	Dry	4/20/2005	1058	73	44	29.97	5	78.26
459	A-3b	100	65	PJ-9	Human-M	35	269	Yes	None	None	None	None	Dry	4/20/2005	1059	73	44	29.97	5	78.26
460	A-3b	100	65	PJ-10	Human-M	35	267	Yes	None	None	None	None	Dry	4/20/2005	1100	73	44	29.97	5	78.26
462	A-3b	120	79	PJ-7	Human-M	35	228	Yes	None	None	None	None	Dry	4/20/2005	1101	73	44	29.97	10	83.86
463	A-3b	120	79	PJ-8	Human-M	35	244	Yes	None	None	None	None	Dry	4/20/2005	1102	73	44	29.97	12	77.98
464	A-3b	120	79	PJ-9	Human-M	35	269	Yes	None	None	None	None	Dry	4/20/2005	1102	73	44	29.97	5	98.56
465	A-3b	120	79	PJ-10	Human-M	35	267	Yes	None	None	None	None	Dry	4/20/2005	1103	73	44	29.97	10	83.86
467	I	100	67	PJ-7	Human-M	35	258	Yes	None	None	None	None	Dry	4/20/2005	1105	73	44	29.97	7	75.28
468	I	100	67	PJ-8	Human-M	35	274	Yes	None	None	None	None	Dry	4/20/2005	1106	73	44	29.97	10	66.46
469	I	100	67	PJ-9	Human-M	35	299	Yes	None	None	None	None	Dry	4/20/2005	1107	73	44	29.97	11	63.52
470	I	100	67	PJ-10	Human-M	35	297	Yes	None	None	None	None	Dry	4/20/2005	1108	73	44	29.97	8	72.34
472	I	120	79	PJ-7	Human-M	35	258	Yes	None	None	None	None	Dry	4/20/2005	1109	73	44	29.97	13	75.04
473	I	120	79	PJ-8	Human-M	35	274	Yes	None	None	None	None	Dry	4/20/2005	1110	73	44	29.87	12	77.98
474	I	120	79	PJ-9	Human-M	35	299	Yes	None	None	None	None	Dry	4/20/2005	1111	73	44	29.87	14	72.1
475	I	120	79	PJ-10	Human-M	35	297	Yes	None	None	None	None	Dry	4/20/2005	1112	73	44	29.87	10	83.86
476	A-1b	60	61	S-39	Human-F	No	145	Yes	None	None	None	None	Dry	4/21/2005	1000	51	71	30.04		
477	A-1b	60	61	D-18	Human-F	No	170		None	None	None	None	Dry	4/21/2005	1001	52	69	30.04		
478	A-1b	80	69	S-39	Human-F	No	145	Yes	None	None	None	None	Dry	4/21/2005	1003	53	69	30.04		
479	A-1b	80	69	D-18	Human-F	No	170		None	None	None	None	Dry	4/21/2005	1005	52	69	30.04		
480	A-3b	60	61	S-39	Human-F	35	180	Yes	None	None	None	None	Dry	4/21/2005	1008	52	69	30.04		
481	A-3b	60	61	D-18	Human-F	35	220	Yes	None	None	None	None	Dry	4/21/2005	1011	52	69	30.04		
482	A-3b	80	70	S-39	Human-F	35	180	Yes	None	None	None	None	Dry	4/21/2005	1014	52	69	30.04		
483	A-3b	80	71	D-18	Human-F	35	220	Yes	None	None	None	None	Dry	4/21/2005	1019	52	69	30.04		
484	I	60	61	S-39	Human-F	35	210	Yes	None	None	None	None	Dry	4/21/2005	1022	52	69	30.04		
485	I	60	61	D-18	Human-F	35	250	Yes	None	None	None	None	Dry	4/21/2005	1024	52	69	30.04		
486	I	80	69	S-39	Human-F	35	210	Yes	None	None	None	None	Dry	4/21/2005	1027	52	69	30.04		
487	I	80	71	D-18	Human-F	35	250	Yes	None	None	None	None	Dry	4/21/2005	1032	52	69	30.04		